

LIBRARY 516

REDUCING EXPOSURES TO INDOOR AIR
POLLUTANTS IN CALIFORNIA:
EXISTING AUTHORITIES
AND RECOMMENDED ACTIONS

FINAL REPORT



State of California
AIR RESOURCES BOARD

RESEARCH DIVISION

December, 1989

State of California

AIR RESOURCES BOARD

REDUCING EXPOSURES TO INDOOR AIR
POLLUTANTS IN CALIFORNIA:
EXISTING AUTHORITIES AND RECOMMENDED ACTIONS
FINAL REPORT -- VOLUME I

December, 1989

Prepared by:

RESEARCH DIVISION

Peggy Jenkins, Coordinator
Thomas J. Phillips
Catherine Caraway
Dr. Shankar B. Prasad

Reviewed by:

John R. Holmes, Chief, Research Division

Clerical Assistance: Emma Plasencia, Gloria Ambriz,
Linda Eppler, Hazel Lunetta, Letty Reid

ACKNOWLEDGEMENTS

We wish to thank the many federal, State, and local government employees and staff of private organizations, who are truly too numerous to list individually, who provided hundreds of documents for our use in preparing this report and who generously shared their knowledge and files with us. Many of them also reviewed and provided comments on draft versions of the report. We also thank our co-workers for their patience during the production of this report, and our managers for their support and their constructive comments on the various drafts. Finally, we extend an especially heartfelt thanks to the clerical staff who spent many hours, including much overtime, assisting us on this project.

State of California
AIR RESOURCES BOARD

Resolution 89-49

April 14, 1989

Agenda Item No.: 89-7-1

WHEREAS, the Air Resources Board conducts a special research program to obtain the information on indoor air quality and personal exposure needed to conduct indoor exposure assessments for toxic pollutants pursuant to Health and Safety Code Section 39660.5;

WHEREAS, the Board has previously reviewed information obtained by staff regarding indoor air quality and risks associated with indoor exposure to pollutants in May 1987 and February 1988;

WHEREAS, the Board finds that the people of the State of California spend, on the average, about 86 percent of their time indoors;

WHEREAS, the Board finds that indoor exposures to some air pollutants, including some of those regulated through the Board's Toxic Air Contaminants Program and the Ambient Air Quality Standards Program, are sometimes greater than outdoor exposures;

WHEREAS, the Board finds that health risk of substantial but unknown magnitude is posed by exposures to indoor air pollution;

WHEREAS, the Board finds that a number of government agencies are making efforts to address exposures to indoor air pollution, but no single state or federal agency has explicit authority to fully address non-occupational indoor exposures;

WHEREAS, the Board finds that, notwithstanding the efforts of such agencies, additional effort is warranted; and

WHEREAS, the Board finds specifically that federal agencies have substantial authority to control, and to coordinate the control of, indoor sources of pollution, but that authority is not currently being fully utilized to address indoor pollution.

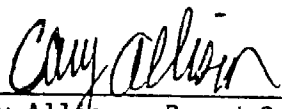
NOW, THEREFORE, BE IT RESOLVED, that the Board concurs with the findings and recommendations of the staff report entitled "Reducing Exposures to Indoor Air Pollutants in California: Existing Authorities and Recommended Actions," dated April 1989, and that the Board hereby:

- A. Accepts and endorses the findings and recommendations of said report;
- B. Directs staff to develop, in conjunction with other State agencies, a State plan for action to assure reduction, and where feasible prevention, of exposure to indoor air pollutants, and that such plan should rely on existing authorities to the extent feasible, include memoranda of understanding among appropriate State agencies, and include explicit goals, objectives, target dates, and progress review periods;

- C. Directs staff to develop, for Board consideration, health-based indoor air quality guidelines for non-occupational indoor environments, in order to identify safe indoor exposure levels for Californians when such levels can be identified, and to provide guidance in reducing indoor exposures to pollutants for which safe levels of exposure cannot be identified;
- D. Directs staff to assist the Department of Health Services and other appropriate State and local agencies in developing indoor air quality education programs;
- E. Directs staff to continue indoor air quality research at a priority level consistent with the apparent risk of indoor exposures and available resources; and
- F. Encourages the U.S. Congress and relevant federal agencies to take additional actions to control, and to coordinate the control of, sources of indoor pollution.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to take appropriate and necessary actions to carry out these recommendations.

I hereby certify that the above
is a true and correct copy of
Resolution 89-49, as adopted by
the Air Resources Board.



Cary Allison, Board Secretary

REDUCING EXPOSURES TO INDOOR AIR
POLLUTANTS IN CALIFORNIA:
EXISTING AUTHORITIES AND RECOMMENDED ACTIONS

TABLE OF CONTENTS

<u>VOLUME I</u>	<u>PAGE</u>
LIST OF ABBREVIATIONS.....	i
EXECUTIVE SUMMARY.....	1
I. INTRODUCTION.....	10
II. BACKGROUND	
A. The Significance of Indoor Air Quality.....	12
B. Health Effects and Risk.....	12
C. Techniques for Improving Indoor Air Quality.....	14
III. SUMMARIES OF AGENCY AUTHORITIES AND ACTIVITIES	
A. Federal Agencies.....	18
Environmental Protection Agency.....	19
Consumer Product Safety Commission.....	21
Occupational Safety and Health Administration.....	23
Department of Energy/Bonneville Power Administration.....	26
Department of Housing and Urban Development.....	29
Department of Health and Human Services.....	32
Department of Transportation.....	34
Other Federal Agencies.....	35
B. State Agencies.....	35
Department of Health Services.....	36
Air Resources Board.....	39
Cal-OSHA.....	42
California Energy Commission.....	46
Department of Consumer Affairs.....	48
Department of Housing and Community Development.....	51
Department of Food and Agriculture.....	53
Other State Agencies.....	55
C. Local Agencies and Private Groups.....	56
Air Pollution Control Districts.....	57
City and County Governments.....	58
Standards Organizations/Private Groups.....	60
D. Summary Matrices.....	62

VOLUME I -- continued

PAGE

IV. MITIGATION NEEDS AND RECOMMENDED ACTIONS TO ADDRESS THEM	
A. General Needs and Recommendations.....	64
B. Needs and Recommendations Related to Source Controls.....	68
C. Needs and Recommendations Related to Building and Ventilation Standards.....	76
D. Education Needs and Recommendations.....	80
E. Continuing Research Needs and Recommendations.....	82
V. STAFF RECOMMENDATIONS TO THE BOARD.....	83
REFERENCES.....	85

VOLUME II -- APPENDICES

A. Selected Portions of 1987 ARB IAQ Briefing Paper.....	A-1
FEDERAL AGENCIES -- IAQ Authority and Activities	
B. Environmental Protection Agency (EPA)..... Committee on Indoor Air Quality (CIAQ)	B-1
C. Consumer Product Safety Commission (CPSC).....	C-1
D. Occupational Safety and Health Administration (OSHA).....	D-1
E. Department of Energy (DOE)..... Bonneville Power Administration (BPA)	E-1
F. Housing and Urban Development (HUD).....	F-1
G. Department of Health and Human Services (DHHS)..... Public Health Service (PHS) Centers for Disease Control (CDC) Office on Smoking and Health (OSH) National Institute for Occupational Safety and Health (NIOSH) Food and Drug Administration (FDA) National Institutes for Health (NIH)	G-1
H. Department of Transportation (DOT).....	H-1
I. Department of Defense (DOD).....	I-1
J. National Aeronautics and Space Administration (NASA).....	J-1
K. National Institute of Standards and Technology (NIST)..... (Formerly National Bureau of Standards)	K-1

STATE AGENCIES -- IAQ Authorities and Activities

L. Department of Health Services (DHS).....	L-1
California IAQ Interagency Working Group (IWG)	
M. Air Resources Board (ARB).....	M-1
N. Cal-OSHA.....	N-1
O. California Energy Commission (CEC).....	O-1
P. Department of Consumer Affairs (DCA).....	P-1
Division of Consumer Services and Legislation	
Bureau of Home Furnishings and Thermal Insulation	
Board of Cosmetology	
Structural Pest Control Board	
Contractors State License Board	
Board of Architectural Examiners	
Other DCA Boards	
Q. Housing and Community Development (HCD).....	Q-1
R. Health and Welfare Agency - Proposition 65.....	R-1
S. Department of Food and Agriculture (CDFA).....	S-1
T. Department of General Services (DGS).....	T-1
Office of the State Architect (OSA)	
U. State Building Standards Commission (SBSC).....	U-1

LOCAL AGENCIES AND OTHER GROUPS -- IAQ Authorities and Activities

V. Air Pollution Control Districts (APCDS).....	V-1
W. Local Governments.....	W-1
X. Standards Organizations and Other Groups.....	X-1

LIST OF ABBREVIATIONS

I Agencies/Groups

ACGIH	American Conference of Governmental Industrial Hygienists
APCD	Air Pollution Control District
ARB	California Air Resources Board
ASHRAE	American Society of Heating, Refrigerating and Air- Conditioning Engineers, Inc.
ASTM	American Society for Testing and Materials
BAAQMD	Bay Area Air Quality Management District
BHFTI	Bureau of Home Furnishings and Thermal Insulation
BLS	Bureau of Labor Statistics
BOC	California Board of Cosmetology
BPA	Bonneville Power Administration
CAC	County Agricultural Commissioner
Cal-OSHA	California Occupational Safety and Health Program, California Department of Industrial Relations
CDC	Centers for Disease Control
CDFA	California Department of Food and Agriculture
CEC	California Energy Commission
CEHIC	Center for Environmental Health and Injury Control
CIAQ	Federal Interagency Committee on Indoor Air Quality
CPSC	U.S. Consumer Product Safety Commission
CSLB	California Contractors State License Board
DCA	California Department of Consumer Affairs
DGS	California Department of General Services
DHEW	U.S. Department of Health, Education and Welfare (now DHHS)
DHHS	U.S. Department of Health and Human Services
DHS	California Department of Health Services
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy

DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
FAA	Federal Aviation Administration
FDA	U.S. Food and Drug Administration
GAO	U.S. General Accounting Office
GRI	Gas Research Institute
HCD	California Department of Housing and Community Development
HUD	U.S. Department of Housing and Urban Development
IAQP	Indoor Air Quality Program, DHS
IWG	California Indoor Air Quality Interagency Working Group
NASA	National Aeronautics and Space Administration
NCHS	National Center for Health Statistics
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
OSHA	U.S. Occupational Safety and Health Administration
PHS	U.S. Public Health Service
SBSC	State Building Standards Commission
SCAQMD	South Coast Air Quality Management District
SPCB	California Structural Pest Control Board

II Acts/Laws/Codes/Standards

AHERA	Asbestos Hazard Emergency Response Act
BPC	California Business and Professions Code
CAA	Clean Air Act
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CFR	Code of Federal Regulations
CPSA	Consumer Product Safety Act
FAC	California Food and Agriculture Code

FHSA	Federal Hazardous Substances Act
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FR	Federal Register
HCS	Hazard Communication Standard
HSC	California Health and Safety Code
MPS	Minimum Property Standards
NESHAPS	National Emission Standards for Hazardous Air Pollutants
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
TSCA	Toxic Substances Control Act
UMTRCA	Uranium Mill Tailings Radiation Control Act
USC	United States Code

III General/Pollutants

CFC	Chlorofluorocarbons
CO	Carbon monoxide
ETS	Environmental tobacco smoke
FY	Fiscal year
HVAC	Heating, ventilating, and air conditioning
IAQ	Indoor air quality
MSDS	Material Safety Data Sheets
NO ₂	Nitrogen dioxide
PAH	Polynuclear aromatic hydrocarbon
PEL	Permissible exposure limit
PM ₁₀	Particulate matter of less than 10 micrometers in aerodynamic diameter
REL	Recommended exposure limit
RSP	Respirable suspended particles
TAC	Toxic air contaminant
TEAM	Total exposure assessment methodology
TLV	Threshold limit value
UFFI	Urea-formaldehyde foam insulation
VOC	Volatile organic chemical

EXECUTIVE SUMMARY

I. BACKGROUND

In May, 1987, staff presented information to the Board regarding the health effects and indoor concentrations of air pollutants and issues surrounding indoor air quality, including the limited response of government agencies to indoor air quality problems. Examination of available information indicated that indoor air pollution poses a serious risk to human health in addition to the known risks from ambient (outdoor) air pollution. Many air pollutants are found at higher levels indoors than outdoors and, in some cases, indoor concentrations have been found to exceed health-based ambient standards that the Board and the U.S. Environmental Protection Agency have set for them. In addition, national surveys of human activity patterns indicate that people, on the average, spend 90 percent of their time indoors.

At the Board's request, staff has prepared this follow-up report which examines the various authorities and activities of federal, State, and local government agencies related to indoor air quality, and assesses the need for further authority and/or actions on the part of California government. This report recommends broad actions which can be taken by the Board and others to reduce exposures to indoor air pollutants in California. Draft versions of this report were reviewed by the agencies discussed herein, and all comments received were considered by ARB staff in preparing the final report.

II. INDOOR AIR POLLUTANT SOURCES AND CONTROL STRATEGIES

Indoor sources of pollutants include cigarettes; combustion appliances, such as gas heaters and stoves; building materials, such as plywood, paint, and insulation; consumer products, including aerosol sprays, solvents, and pesticides; home and office furnishings; and human activities, such as vacuuming and woodworking. Exposure to indoor pollutants may be reduced through removal, substitution, or modification of pollutant sources; improved ventilation; changes in people's activities; and air purification or filtration.

Source removal, substitution, or modification are the preferred control techniques for most pollutants since they assure a reduction in exposure or in the potential for exposure. However, improved ventilation (increased fresh air exchange) is the most frequently employed control technique, because it quickly and effectively reduces indoor concentrations of many pollutants. Nonetheless, increased ventilation is inadequate or inappropriate for control of some pollutants, such as particulate pollutants, which may become suspended in the air where they are more likely to be inhaled. Because human activities are a significant factor in determining indoor air quality, changes in those activities, such as cessation of smoking, can clearly have a major effect on indoor air pollutant concentrations and indoor exposures to pollutants. Finally, air filtration or purification is a control technique that is useful in improving indoor air quality under certain conditions, but it is generally more expensive and less effective in reducing pollutant concentrations and exposures than other available methods.

III. GOVERNMENTAL RESPONSE

Until very recently, governmental response to indoor air quality problems has been limited, since no single federal or State agency has comprehensive regulatory authority over indoor air quality. At the federal level, indoor air quality activities are coordinated through the interagency Committee on Indoor Air Quality (CIAQ). A total of 16 federal agencies participate in the CIAQ, which is chaired by the Environmental Protection Agency (EPA) and three other agencies. However, no federal agency has direct or explicit authority over indoor air quality, except for the Occupational Safety and Health Administration (OSHA) which has authority over workplace air quality. As a result, the federal approach to addressing indoor air quality has consisted primarily of research and public education actions taken by a few agencies, and only recently has serious coordination among federal agencies been established.

Largely due to pressure from Congress, EPA has increasingly taken a leadership role in addressing indoor air quality despite the fact that EPA has only very limited regulatory authority over indoor air quality. In

the EPA Indoor Air Quality Implementation Plan (1987), EPA indicates that it will address indoor problems primarily through research, development of mitigation technology, and transfer of information to state and local governments. The Implementation Plan clearly indicates that the actual mitigation of indoor air quality problems will be left to state and local governments. Additionally, no federal resources have been specifically designated for state and local indoor air quality mitigation activities, except for limited funding for radon- and asbestos-related activities.

In California, no formal State plan or comprehensive process has been developed to address indoor air quality problems. Since 1983, the Department of Health Services (DHS) has had the responsibility to conduct indoor air quality research and to coordinate the State's response to indoor problems. DHS has conducted significant research, has undertaken many public education activities, and has issued an indoor air quality guideline for formaldehyde. DHS also chairs the California Indoor Air Quality Interagency Working Group (IWG), an informal group of State agency representatives who meet quarterly or more frequently to discuss indoor air quality issues.

Two significant mitigation measures to specifically address indoor air quality have been promulgated by State agencies. The sale and installation of urea formaldehyde foam insulation (UFFI) was effectively banned by the California Energy Commission in 1982. In 1986, the Occupational Safety and Health Standards Board approved the Minimum Building Ventilation Standard which requires proper operation and maintenance of ventilation systems but which does not include strong compliance provisions.

Local governmental units have taken significant actions to reduce exposure to environmental tobacco smoke through passage of many city and county ordinances which restrict cigarette smoking (ANR, 1987; ANR, 1988). However, local government has neither adequate resources, nor in most cases, adequate expertise to address the breadth of indoor air quality problems and issues that face the State today. Although local government may be the best body to implement some specific indoor air quality

mitigation measures, State-level guidance and technical and financial assistance appear necessary before local governments can address specific indoor air quality problems effectively.

IV. MITIGATION NEEDS AND RECOMMENDATIONS TO ADDRESS THEM

A. GENERAL NEEDS AND RECOMMENDATIONS

Within California, no comprehensive State plan to address indoor air quality has been developed, and few specific actions have been taken that will actually reduce exposures to indoor pollutants. With the exception of research activities, coordination among State agencies to actively address indoor air quality is minimal. The federal government has clearly indicated that actual mitigation of indoor air quality problems will be left to state and local governments.

Recommendation 1: A comprehensive State plan which assures reduction of indoor air pollutant exposures in California and which includes memoranda of understanding among appropriate State agencies should be developed. The plan should include explicit goals, objectives, target dates and periodic progress reviews.

Currently, there is no set of national or State guidelines available which adequately indicates to building managers, members of the public, and health practitioners how healthful indoor environments might be defined or achieved. When an indoor air quality problem arises, it is often not clear how extensive mitigation should be to restore a healthful public or residential indoor environment, nor whether a healthful environment has been achieved once mitigation measures have been implemented.

Recommendation 2: As sufficient data become available, the ARB staff should develop health-based indoor air quality guidelines for non-occupational indoor environments for consideration by the Board. These guidelines should identify safe exposure levels for Californians where such levels can be identified, and provide guidance in reducing indoor exposures to pollutants for which safe levels cannot be identified.

Currently there are no State or local agencies with clear authority and adequate resources to respond to citizens' requests for assistance in identifying and solving residential indoor air quality problems. Most

citizens with potential indoor air problems are provided information over the telephone by one or more government agencies or private groups but must turn to private air testing firms if their problem is not readily resolved through telephone advice. Because there are no certification or registration requirements for such companies, citizens have no way of judging whether companies which offer indoor air testing services are in fact knowledgeable about the field and are familiar with all relevant aspects of indoor air quality assessment.

Recommendation 3: Local health and environmental health departments and/or air pollution control districts (APCDs) should be provided with the staff, training, equipment, and fiscal resources to conduct initial residential inspections when necessary in response to citizen requests for assistance in identifying and resolving residential indoor air quality problems. Where necessary, a clear mandate and a specific funding mechanism should be provided for this function.

Recommendation 4: Private companies offering to provide residential inspection, testing, and mitigation services for indoor air quality problems in California should be required to complete a State certification process. The State certification process should require at a minimum: completion of a State-offered or State-approved indoor air quality inspection training course; written and field tests; and recertification every three to five years.

B. NEEDS AND RECOMMENDATIONS RELATED TO SOURCE CONTROLS

Although many federal agencies and a few State agencies have some degree of authority over one or more indoor sources of pollutants, none has comprehensive authority, and most do not have specific authority to address indoor air pollutant emissions. The Consumer Product Safety Commission (CPSC), the agency with the broadest authority over consumer products, is hindered like other federal regulatory agencies by frequent lawsuits and lengthy federal rule-making requirements and has turned almost exclusively to voluntary standards. The CPSC and some other agencies also rely extensively on labeling of hazardous products to achieve risk reduction. However, available information regarding illiteracy and immigration rates in California indicates that labeling is an inadequate risk reduction measure in the State since many California residents cannot read or understand instructions on labels adequately. Also, products which could be regulated by the federal government for the

purpose of reducing indoor exposures (but are not) are generally not regulated by any California agencies. Consequently, only a few indoor pollutant sources have been regulated for the purpose of reducing indoor emissions.

Recommendation 5: The Air Resources Board should be given responsibility to develop control measures to be used to mitigate indoor sources of non-occupational exposures to designated Toxic Air Contaminants and pollutants for which the Board has adopted State Ambient Air Quality Standards, where no such responsibility currently exists.

This recommendation is made based on the need for a clear mandate/authority for a single agency to oversee and, as necessary, regulate indoor pollutant sources. The ARB is the most appropriate State agency for this role because it has a primary mission to protect air quality, a clearly established regulatory mechanism, extensive experience in addressing pollutant emissions from a variety of sources, and significant experience in the fields of exposure assessment and indoor air quality. The ARB has also demonstrated the ability to establish goals and objectives and to carry out programs in a timely, effective manner. Implementation of indoor mitigation measures can be most effectively and efficiently carried out through existing ARB risk management programs.

C. NEEDS AND RECOMMENDATIONS RELATED TO BUILDING AND VENTILATION STANDARDS

A number of agencies at both the federal and State levels of government as well as local city and county governments have some degree of authority to set standards for building and ventilation system design and construction. In light of the apparently increasing number of cases of sick-building syndrome being reported and recently-gained knowledge regarding the risk posed by seepage of radon gas into buildings, it would appear that California's building standards should be reviewed to determine whether revisions are necessary to assure good indoor air quality. Assembly Bill 4655 (Tanner), signed by the Governor in September, 1988, requires the California Energy Commission (CEC) to review its existing standards for residential and non-residential buildings to determine whether modifications are needed to reduce the potential for indoor air pollution.

Recommendation 6: The many State and local agencies other than the CEC that promulgate building standards should also conduct a review of their existing standards comparable to CEC's mandated review, to assure that indoor air quality is protected and not compromised by those standards.

Recommendation 7: As areas of high radon risk are identified, measures which minimize the entry of radon into new buildings should be incorporated into State and local building standards.

By far the greatest single problem that results in unhealthy indoor air quality is inadequate operation and maintenance of ventilation systems. Although a number of governmental bodies regulate the design and construction of buildings and ventilation systems, the operation and maintenance of buildings and ventilation systems remain inadequately regulated. Only the Minimum Building Ventilation Standard approved by the Occupational Safety and Health Standards Board in 1986 includes a direct requirement for proper maintenance and operation of ventilation systems, but it applies only to workplaces and does not provide strong compliance requirements. The provisions of the Minimum Building Ventilation Standard, together with stronger compliance requirements, are important, necessary components of any indoor air quality management plan.

Recommendation 8: The operation and maintenance of all non-residential and group residential buildings and ventilation systems should be regulated at least to the extent provided for by Cal-OSHA's Minimum Building Ventilation Standard, that is, that heating, ventilation, and air conditioning systems should be operated and maintained as they were intended to be. In addition, any new standard developed for operation and maintenance should include provisions and resources for active inspection and enforcement by appropriate local officials.

D. EDUCATION NEEDS AND RECOMMENDATIONS

There is a need for increased public education and State and local agency education on the subject of indoor air quality. Individuals can significantly affect their own exposures to indoor air pollutants through actions they do or do not take, and a number of public agencies can (unknowingly) affect indoor air quality in carrying out their respective mandates as well. Additionally, knowledge and actions of local government personnel are particularly critical in reducing citizens' exposures to pollutants, since they are the ones to whom citizens first turn for information and assistance.

Recommendation 9: Public education efforts should be increased through development and statewide distribution of additional informational materials. Targeted indoor air quality training seminars should be developed and provided by knowledgeable State agency staff for other State agencies and for local agency personnel such as building inspectors, county health and environmental health department officers and staff, and air pollution control district staff.

E. RESEARCH NEEDS AND RECOMMENDATIONS

Resources allocated to indoor air quality assessment and mitigation research are low relative to the apparent risk posed by indoor pollution and relative to expenditures for many other environmental risk categories. Significant information gaps which need to be further addressed include, among others: indoor pollutant concentrations and exposure levels in California; the health and economic consequences of California indoor pollution; and the effectiveness of various mitigation measures such as "bake-outs" of new buildings.

Recommendation 10: State agencies should gather the additional information needed to accurately and adequately determine the health risks posed by exposure to indoor pollution in California, the economic consequences of indoor exposures, and effective mitigation measures to reduce or prevent those exposures.

V. STAFF RECOMMENDATIONS TO THE BOARD

Staff recommends that the Board:

- A. Accept and endorse the findings and recommendations of this report.
- B. Direct staff to develop, in conjunction with other State agencies, a State plan for action to assure reduction, and where feasible prevention, of exposure to indoor air pollutants. The plan should include memoranda of understanding among relevant State agencies and propose new authority only where it is clearly needed to assure mitigation of indoor exposures. The plan should include explicit goals, objectives, target dates, and periodic progress reviews.
- C. Direct staff to develop, for Board consideration, health-based indoor air quality guidelines for non-occupational indoor environments, in order to identify safe indoor exposure levels for Californians when such levels can be identified, and to provide guidance in reducing indoor exposures to pollutants for which safe levels of exposure cannot be identified.

- D. Direct staff to assist the Department of Health Services and other State and local agencies in developing indoor air quality education programs.
- E. Direct staff to continue indoor air quality research at a priority level consistent with the apparent risk of indoor exposures and available resources.
- F. Encourage the U.S. Congress and relevant federal agencies to take additional actions to control and to coordinate the control of sources of indoor pollution.

**REDUCING EXPOSURES TO INDOOR AIR
POLLUTANTS IN CALIFORNIA:
EXISTING AUTHORITIES AND RECOMMENDED ACTIONS**

I. INTRODUCTION

California Health and Safety Code (HSC) Section 39660.5 requires the Board to consider indoor exposures, in addition to outdoor exposures, when assessing the risk posed by toxic air pollutants addressed under the ARB Toxic Air Contaminants Program. To obtain needed information regarding indoor exposures to these and other pollutants, the staff has initiated an indoor air quality/personal exposure research program. As more information has been obtained, the staff has become increasingly concerned regarding potentially serious exposures to indoor pollutants which are currently not addressed or are only inadequately addressed.

In May, 1987, staff presented information to the Board regarding: the concentrations and health effects of indoor air pollutants; factors that can affect indoor pollutant levels; techniques of controlling indoor pollutants; and issues surrounding indoor air quality, including the response of government agencies to indoor air quality problems. That initial report to the Board indicated an apparent need for further actions to mitigate and prevent indoor air quality problems. The report noted that, although public education is an important aspect of any indoor air quality protection strategy, public education alone is generally not a sufficient measure for protecting public health. This is so because some groups of the population, particularly children, are incapable of appropriately responding to the information provided to them.

Consequently, at the Board's request, staff has prepared this follow-up report which examines the various authorities and activities of federal, State, and local government agencies related to indoor air quality, and assesses the need for further authority and/or actions on the part of California government. This report recommends broad actions that can be taken by the Board and others to assure healthful indoor air quality in California.

Information regarding authorities and activities related to indoor air quality was solicited in December, 1987 and January, 1988 from all State and federal agencies which staff believed might affect indoor air quality by their actions. In all cases, further information beyond the initial responses was pursued, and detailed discussions (see appendices) were prepared for those agencies which have or appeared to have relevant authority. As they were completed, preliminary drafts of the appendices were sent for review to the agency staff who had provided the information. Later, in February, 1989, the complete draft document was sent to appropriate agency heads and staff for review. In both cases, all comments received were considered by ARB staff, and changes were made to the draft documents as deemed appropriate.

II. BACKGROUND

A. THE SIGNIFICANCE OF INDOOR AIR QUALITY

Current information indicates that indoor air pollution poses a potentially serious risk to human health in addition to the known risks from ambient (outdoor) air pollution. Many air pollutants are found at higher levels indoors than outdoors and, in some cases, indoor concentrations have been found to exceed health-based ambient standards that the Board and the U.S. Environmental Protection Agency have set for them (see Appendix A). In addition, national surveys of human activity patterns indicate that people, on the average, spend 90 percent of their time indoors (Szalai, 1972; Robinson, 1977). Members of sensitive subgroups of the population, such as the elderly, infants, and persons with pulmonary or cardiovascular disease, may spend nearly 100 percent of their time indoors. Accordingly, in some cases critical exposures to some pollutants are experienced indoors, particularly for members of the most sensitive population subgroups.

B. HEALTH EFFECTS AND RISKS

Indoor pollutants that are known to pose significant health risks include tobacco smoke, respirable particles, carbon monoxide, nitrogen dioxide, formaldehyde and other volatile organic chemicals, radon, asbestos, and biological contaminants. These pollutants have the potential to cause a variety of adverse effects at indoor concentrations, ranging from headache and throat irritation to respiratory disease and cancer. Except for tobacco smoke, and to a limited extent radon and perhaps formaldehyde, accurate quantification of the actual health risk posed by indoor air pollutants in California is tenuous at this time because specific California indoor pollutant exposure information is very limited. However, enough is known in terms of estimated deaths per year and relative indoor/outdoor exposures to demonstrate clearly the high risk posed by involuntary exposure to some indoor air pollutants relative to risks posed by involuntary exposures to outdoor pollutants that are currently regulated.

An examination of available information regarding indoor exposures to a few substances on the Board's list of candidate toxic air contaminants is illustrative, particularly since most are believed to be carcinogenic and may cause harm even at very low exposure levels. Exposure to environmental tobacco smoke, for example, is estimated to result in about 5,000 lung cancer deaths per year in U.S. nonsmokers (Repace and Lowrey, 1985), and about 46,000 deaths per year from all types of cancer and heart disease (Wells, 1988). A rough extrapolation of these estimates to California nonsmokers would indicate that as many as 500-4600 Californians die prematurely each year due to involuntary exposure to tobacco smoke. Similarly, exposure to elevated indoor concentrations of radon daughters (radioactive decay particles from radon gas) is estimated to result in 5,000-20,000 lung cancer deaths per year in the U.S. (NRC, 1988); rough extrapolation to California residents indicates that as many as 500-2000 Californians may die each year from chronic exposure to radon decay products.

Concentrations of formaldehyde are frequently higher indoors than outdoors. Formaldehyde levels in more than 500 mobile homes in California were reported at 0.01 to 0.46 ppm (Sexton et al., 1986), and another study found average concentrations in 60 non-mobile homes ranging from 0.018 to 0.12 ppm (SAI, 1984). Outdoor levels of formaldehyde are typically below 0.030 ppm (NRC, 1981; Mackay et al., 1988). The California Department of Health Services recommends that indoor exposures do not exceed 0.05 ppm.

Indoor exposures to polycyclic aromatic hydrocarbons, or PAHs, are greater than outdoor exposures when indoor sources are present, e.g., in buildings where cigarette smoking is allowed or in homes using woodstoves (Sexton et al., 1986; Surgeon General, 1986). Indoor exposures are also believed to be frequently greater for other toxic pollutants such as asbestos, some aromatic compounds, and some chlorinated hydrocarbons. Additional detailed information regarding the health effects, sources, and indoor and outdoor concentrations of these and other pollutants is provided in Appendix A.

C. TECHNIQUES FOR IMPROVING INDOOR AIR QUALITY

An understanding of the factors that affect indoor air quality and the techniques available for controlling indoor air pollution is necessary before one can assess the adequacy of existing control efforts. Some of the major factors that affect indoor exposures to pollutants include the increasing use of volatile chemicals in building materials, home furnishings, and various consumer products; the use of malfunctioning or unvented combustion appliances, such as some gas and kerosene heaters; the rate of air exchange between the indoor and outdoor environments through air infiltration and ventilation; the type and length of human activities, such as use of aerosol sprays and solvents and tobacco smoking; and the proximity of buildings to major outdoor pollutant sources. Effective control techniques can address one or more of these factors, and include the elimination or modification of indoor pollutant sources, improved ventilation, changes in people's activities, and air filtration or purification.

1. Source Controls

Source removal, substitution, or modification are the preferred control techniques for most pollutants since they assure a reduction in exposure or in the potential for exposure. This is particularly important for pollutants that appear to have no threshold for effects, such as most carcinogens, since any exposure may contribute to an adverse health effect. Control of indoor sources is the most effective means of reducing indoor exposures to many of the substances identified by the Board as toxic air contaminants, since many of them are carcinogens with no identifiable health effect threshold. Source control is also preferred because source strength is usually the primary factor which determines indoor concentrations.

Examples of source removal, substitution, and modification include the substitution of alternative insulation materials for urea formaldehyde foam insulation (UFFI), which occurred in the late 1970's after occupants suffered acute effects from offgassing of formaldehyde from UFFI.

Similarly, asbestos pipe insulation, asbestos ceiling tiles and other asbestos building materials must sometimes be removed (when they are worn or frayed past the point where patching would be adequate) and must be replaced with materials made of other, less harmful substances. Source substitution also includes replacement of harmful chemicals sometimes found in carpet adhesives, aerosol sprays, and other consumer products. Other source modifications which can achieve major reductions in indoor pollutant exposures include the use of low-emission burners and pilotless ignition in gas appliances, venting to the outdoors for all indoor combustion appliances, and use of high-efficiency filters in vacuum cleaners. Many source controls are best implemented through working with manufacturers at the product development and production stages.

2. Improved Air Exchange

Increased outdoor air exchange is the most frequently employed IAQ control technique, and has been used for centuries to enable people to inhabit enclosed environments. Air exchange may be passive, as through seepage through cracks in floors and walls or through an open window, or it may be accomplished actively through fans (mechanical ventilation). Reduced air infiltration resulting from weatherization techniques such as caulking and weatherstripping can have a significant effect on indoor air quality when ventilation systems are not adjusted or changed to properly compensate for the reduced exchange of indoor and outdoor air. Air exchange rates (ACH, air changes per hour) in older residences are generally higher than rates in new energy-efficient homes. Rates for most buildings also vary markedly with weather conditions and with occupant activities such as opening and closing of doors.

Design criteria for mechanical ventilation systems, and sometimes their construction, are largely specified in State and local building codes. Operation and maintenance of ventilation systems are only partially regulated, however, as provided for under the Cal-OSHA Minimum Building Ventilation Standard, which is discussed later. Consequently, filters may become clogged but are not cleaned, objects are left blocking outside air intake vents, or systems are simply not turned on. All of

these can result in fresh air exchange rates significantly lower than that which the designer intended. A simple inspection and correction of obvious problems in the ventilation system is often all that is needed to reduce indoor pollutants to acceptable levels. Of nearly 500 investigations of air quality in office buildings conducted by the National Institute of Occupational Safety and Health (NIOSH) from 1971 through 1987, inadequate ventilation was found to be the primary problem in 52% of the cases (Crandall, 1988).

Because it quickly and effectively reduces indoor concentrations of many pollutants, improved ventilation is the mitigation measure of choice for many IAQ problems. Spot ventilation of confined sources, such as the use of range hood exhaust fans over gas stoves, is also very effective. However, increased ventilation is inappropriate or inadequate for control of some pollutants. Increased ventilation used alone may suspend particulate pollutants such as asbestos, bacteria, and molds, thus increasing the chance that they will be inhaled. Similarly, for volatile pollutants whose emission rates increase as air concentrations decrease (such as formaldehyde emissions from building materials), ventilation is relatively ineffective in reducing exposure. Also, for pollutants with no threshold of effects, ventilation still allows small but potentially harmful exposures. In such situations, then, source controls are much more effective in reducing or eliminating risks.

3. Changes in People's Activities

Because human activities are a significant factor in determining indoor air quality, changes in those activities can clearly have a major effect on indoor air pollutant concentrations and indoor exposures to pollutants. Cessation of smoking, proper or reduced use of cleaning agents and sprays, and proper maintenance of gas appliances are examples of such behavior changes. Generally, changes in behavior are best achieved through public education efforts. It should be noted, however, that public education alone may not be a sufficient measure for protecting public health, since some groups of society, particularly children, are

often incapable of responding appropriately to the information provided to them.

Prohibition of tobacco smoking in public buildings is one regulatory approach that has been taken to reduce exposure caused by human activities. In California, over 120 cities and counties covering about 50 percent of the population have enacted significant non-smoker protection ordinances (ANR, 1987). The other 50 percent of the State's population, however, remains relatively unprotected from involuntary exposure to tobacco smoke in public buildings.

4. Air Filtration/Purification

Air filtration or purification is a control technique that is useful in improving indoor air quality under certain conditions but is generally more costly and less effective in reducing pollutant concentrations and exposures than the other methods just described. Like ventilation, filtration does not completely prevent exposure to toxic substances such as many carcinogens. Air filtration may be useful in small-volume areas and areas of special need, such as hospitals and nursing homes and rooms in which smoking is allowed. Filtration and purification may also be necessary in areas where outdoor air quality is poor. Nursing homes, hospitals, and residences immediately adjacent to freeways, for example, may require purification of outdoor air before it is suitable for long-term breathing indoors by sensitive individuals. However, even in these instances another control technique--proper siting of buildings --is more effective in reducing or preventing harmful exposures.

Particle removers include common low-efficiency glass fiber filters such as those often used in home furnaces, high-efficiency fibrous filters, electrostatic precipitators, and air ionizers. The efficiencies of these filters for use in the home tend to be directly correlated with price. Absorption and adsorption processes can also be used to remove indoor pollutant gases. However, only adsorbent filters like activated charcoal filters are commercially available for residential use, and their effectiveness can be variable.

III. SUMMARIES OF AGENCY IAQ AUTHORITIES AND ACTIVITIES

Indoor air quality authorities and activities of federal, State, and local agencies and activities of private groups are summarized here and are discussed in detail with appropriate citations and references in Appendices B through X. Information supporting all statements found in these summaries may be found in the appropriate appendix. Summary matrices of government agency authorities related to indoor air quality are provided in Section D at the end of this chapter.

A. FEDERAL AGENCIES

At the federal level, indoor air quality activities are coordinated through the interagency Committee on Indoor Air Quality (CIAQ). A total of 16 federal agencies participate in the CIAQ, which is jointly chaired by the Environmental Protection Agency (EPA), the Department of Energy (DOE), the Department of Health and Human Services (DHHS) and the Consumer Product Safety Commission (CPSC). However, no federal agency has direct or explicit authority over indoor air quality, except for the Occupational Safety and Health Administration (OSHA) which has authority over workplace air quality. As a result, the federal approach to addressing indoor air quality has consisted primarily of research and public education actions taken by a few agencies. Only very recently has active coordination among federal agencies been established.

Largely as a result of pressure from Congress, EPA has increasingly taken a leadership role despite the fact that EPA has only very limited authority over indoor air quality (see Appendix B). In the EPA Indoor Air Quality Implementation Plan (1987), EPA indicates that it will address indoor problems primarily through research, mitigation technology development, and transfer of information to state and local governments. However, the Implementation Plan clearly indicates that the actual mitigation of IAQ problems will be left to state and local governments. Additionally, no federal resources have been specifically designated for state and local IAQ mitigation activities, except for limited funding for radon- and asbestos-related activities.

1. Environmental Protection Agency (EPA)

The EPA has authority to conduct research and gather data related to indoor air quality through several of the statutes it administers. However, EPA's regulatory authority under the Clean Air Act (CAA) is limited to outdoor air since the CAA gives EPA authority over "ambient air" which EPA earlier defined in its regulations as "that portion of the atmosphere, external to buildings, to which the general public has access" (40 CFR Section 50.1 [e]; Barnes, 1987; see Appendix B). EPA has only limited authority under other statutes to control specific sources of indoor pollutants for the purpose of reducing indoor exposures. The Toxic Substances Control Act (TSCA) provides EPA with its most direct authority over IAQ, in that it authorizes EPA to identify and control commercial activities involving chemical substances and mixtures (including their manufacture, processing, commercial distribution, use, or disposal) that pose an unreasonable risk to human health or the environment. However, TSCA's utility for addressing indoor pollutant exposures is limited because chemicals must generally be regulated under other federal authorities where appropriate (rather than under TSCA), and TSCA requires consideration of economic factors, in addition to health risk factors, in developing control measures.

Under other statutes (see Appendix B) EPA also regulates:

- o the manufacture, use, and disposal of pesticides, which includes their use in and around buildings;
- o waste management and disposal practices, which may prevent or reduce the migration of toxic gases from landfills into buildings;
- o drinking water, including concentrations of volatile organic compounds and radon which may be emitted from water into the indoor air during domestic and commercial water use; and
- o indoor concentrations of radon in buildings affected by uranium mill tailings.

EPA has also been directed through the Superfund Amendments and Reauthorization Act (SARA, 1986) to assess radon problems nationwide and to develop appropriate and effective radon mitigation techniques. SARA

also required a report to Congress (originally due in fall, 1988 but postponed to April, 1989) regarding federal agency activities and plans related to addressing indoor air quality problems. Recently, Congress also passed the Indoor Radon Abatement Bill (HR 2837), which directs EPA to take an even more active role in radon mitigation and to provide grants to states to assess and address their potential radon problems. The new law also specifically requires EPA to develop model construction standards and techniques for controlling radon levels within new buildings; to provide increased technical assistance to states; to study the extent of radon contamination in schools and federal buildings; and to establish regional radon measurement and mitigation training centers.

EPA's past commitment to indoor air quality issues and activities has fluctuated (see Appendix B), although significant pioneering research was accomplished. Since EPA established a small IAQ policy group in 1986, it has taken a more active role in addressing indoor air quality. The new policy group developed the indoor air policy framework embodied in the EPA Indoor Air Quality Implementation Plan (Plan), which basically takes a non-regulatory approach to addressing IAQ problems. EPA will actively continue research efforts to identify indoor air problems and to develop appropriate mitigation measures, and will provide technical assistance to state and local governments, "to which the public should turn for help in assessing and solving their immediate indoor air quality problems" (Plan, p. 16). EPA will also continue to serve as the primary co-chair of the CIAQ and will promote coordination of IAQ activities at the federal level.

Under its current authority, EPA has taken several regulatory or quasi-regulatory actions to address specific indoor pollutant exposures. Some of these include:

- o assessment and abatement of asbestos in school buildings;
- o prohibition of the use of asbestos in specified building materials;
- o identification of a guideline mitigation level of 4 picocuries per liter (4 pCi/l) for indoor radon concentrations;
- o prohibition of most applications of the structural wood preservatives pentachlorophenol and creosote;

- o cancellation or limitation of the use of certain pesticides, such as lindane, chlordane, and heptachlor; and
- o development of a more protective policy regarding "inert" (non-pesticidal) ingredients in pesticide products.

Other indoor pollutants, including formaldehyde and six chlorinated solvents such as methylene chloride and trichloroethylene, are in various stages of the TSCA and FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) regulatory processes. All of these regulatory and quasi-regulatory actions are discussed further in Appendix B.

EPA has also conducted significant non-regulatory activities related to indoor air quality. Public education efforts are numerous and have included the development of several fact sheets and a general IAQ information document, plus several information guides on asbestos and radon. EPA is also conducting extensive research to assess indoor exposures to pollutants and the risk posed by indoor pollutants, and has pioneered or contributed to major research efforts such as the Total Exposure Assessment Methodology (TEAM) studies and the Six Cities Survey. Some of the current TEAM study work is being done in California under joint funding agreements with the Air Resources Board.

2. Consumer Product Safety Commission (CPSC)

CPSC is an independent regulatory agency whose primary mission is to eliminate or reduce unreasonable risks of injury associated with consumer products. CPSC has broad jurisdiction over consumer products, which are defined as any articles which are produced or distributed for sale to, or use by, consumers in or around the home or in schools, recreation areas, or other non-occupational settings. Certain products are exempted from CPSC authority, including pesticides, cosmetics, tobacco and cigarettes, food, drugs, automobiles, airplanes and firearms. In addition, houses and other buildings are specifically excluded by legislative history and judicial review. However, CPSC does have jurisdiction over home building materials that are sold or distributed as separate products to consumers.

CPSC has the authority under certain conditions to: (1) ban a product; (2) establish mandatory safety standards for products; (3) recall products for repair, replacement or refund; (4) mandate warning labels for products; and (5) cooperate with manufacturers in the development of voluntary product standards. In addressing the need to regulate a consumer product, CPSC must consider not only the health and safety risks associated with use of the product, but also the public's need for the product. Other responsibilities of the CPSC are to: assist consumers in evaluating products; develop uniform safety standards and minimize conflicting state and local regulation; and promote research and investigation into causes and prevention of product-related deaths, injuries, and illnesses.

Considering its relatively limited resources, CPSC has made notable contributions in areas related to IAQ regulation and research. Indoor pollutants regulated to some extent by CPSC through product bans or labeling requirements include asbestos, vinyl chloride, and combustion pollutants from appliances such as unvented gas space heaters and unvented kerosene heaters. The CPSC has recently begun to assess the health risks associated with: chlorocarbons such as methylene chloride found in various consumer products; airborne biological contaminants that may be associated with humidifiers and vaporizers, and exposure to lead by paint removal tools. In its nonregulatory efforts related to IAQ, CPSC has emphasized applied research and public information dissemination. Because its staff and budget are limited, CPSC has tried to concentrate its resources on the most serious hazards associated with consumer products.

Voluntary product standards, rather than product bans and mandatory standards, are currently preferred by CPSC for several reasons. Voluntary standards take less time to develop and implement and are less likely to be challenged legally, so that public protection should occur sooner; they tend to be less intrusive, more responsive to technological change, and cheaper for all concerned. Also, Congress expressed a preference for voluntary product standards in its 1981 amendments to CPSC's mandate.

Voluntary standards would appear to be less effective than mandatory standards because they entail fewer compliance incentives and less stringent criteria than mandatory standards. Also, voluntary standards may produce less risk reduction than that provided by mandatory standards [15 USC 2056(b); Eberle, 1988]. However, the CPSC must rely on voluntary standards unless the standard is inadequate or it is unlikely that there will be substantial compliance. If necessary, CPSC can still act directly by requiring product recall or repair of defective products which present a substantial risk of injury. The effectiveness of voluntary standards will need to be carefully evaluated in the coming years.

CPSC authority pre-empts state or local governments from establishing or continuing in effect any standard or regulation which addresses the same risk of injury addressed by a consumer product safety standard or labeling requirement established by CPSC. However, products and risks not addressed through CPSC regulation may be addressed by other governments. Also, the pre-emption restriction does not appear to apply to products/risks addressed by voluntary standards developed by CPSC in conjunction with other groups (see Appendix C). Exemptions to the pre-emption provision may be made by CPSC upon petition from a state if: 1) the state standard would provide a significantly higher degree of protection from the risk of injury than that provided by the federal provision, and 2) the state standard would not unduly burden interstate commerce (15 USC Sec. 2075). Because of increasing state and local government interest in regulating hazardous products, the CPSC is currently considering regulations that outline a procedure for state and local governments to follow in applying for exemptions from pre-emption (Lacy, 1988; 53 FR 52428). However, under the proposed regulations, the burden of proof by the applicant would remain heavy.

3. Occupational Safety and Health Administration (OSHA)

Under the Department of Labor, OSHA has the responsibility to: promulgate and enforce workplace health and safety standards; maintain a reporting and recordkeeping system to monitor job-related injuries and illnesses; encourage employers and employees to reduce workplace hazards;

establish training programs for occupational safety and health personnel; and provide for the development, analysis, evaluation and approval of state occupational safety and health programs. OSHA's authority extends over all employers, employees, and workplaces except:

- o self-employed persons;
- o farms at which only immediate members of the farm employer's family are employed;
- o state and local government employees; and
- o workplaces already protected by other federal agencies under other federal statutes, such as those regulated by the Mine Safety and Health Administration, the Nuclear Regulatory Commission, and the U.S. Coast Guard.

The primary regulatory authority of OSHA that affects indoor air quality is the authority to develop, promulgate, and enforce air quality standards and related safety standards in the workplace. OSHA standards are based not only on health risk criteria but on economic and technological feasibility as well, and must be deemed necessary by OSHA to remedy a significant risk of material health impairment (53 FR 20979). "Significant risk" has not been specifically defined, but OSHA generally has regulated health hazards that pose risks above one in a thousand over a working lifetime (53 FR 20965). This is clearly less protective than the guideline of protecting against lifetime risks of one in a million used (implicitly or explicitly) by some other state and federal agencies.

Until January, 1989, OSHA standards for about 400 chemicals were largely based on 1968 standard levels of the American Conference of Governmental Industrial Hygienists (ACGIH) and the American National Standards Institute. Since 1971, OSHA had promulgated only 24 new standards, including those for lead, asbestos, vinyl chloride, benzene, and formaldehyde. During the same period, the ACGIH had revised or added nearly 200 limits to its list, and the National Institute for Occupational Safety and Health (NIOSH - the research agency charged with developing recommended standards for OSHA) had made numerous lower pollutant-level recommendations to OSHA. Recognizing that the majority of its standards

were seriously out-dated and that the pollutant-by-pollutant standard-setting process has become too time consuming and cumbersome, OSHA recently proposed (53 FR 20960) and promulgated (54 FR 2332) sweeping revisions to its air quality standards. The amendments reduce the exposure limits for 212 contaminants previously listed on OSHA's standards list, establish exposure limits for 164 substances not previously regulated by OSHA, add or change short-term exposure limits, and set other limits as appropriate. Public hearings on the proposed amendments began in July, 1988, and final rulemaking was completed in January, 1989. The new standards only apply to the General Industry sector. Initial compliance is required by September 1, 1989 using any control methods; OSHA will follow a phased enforcement schedule.

Under pressure, OSHA also promulgated in 1983 the Hazard Communication Standard (HCS), which requires chemical manufacturers and importers to provide information to their employees concerning hazardous chemicals by means of hazard communication programs, and also requires appropriate labeling of containers and provision of material safety data sheets. A successful lawsuit against OSHA resulted in expansion of the HCS in 1987 to include non-manufacturing employers and employees as well. Employer compliance with the HCS is intended to increase employees' awareness of potential pollutant exposures and encourage employees to use appropriate safety procedures and caution in handling hazardous chemicals.

To enforce its standards, OSHA may conduct inspections, issue citations, assess penalties, and grant variances (OSHA, 1985). Inspections may be initiated by OSHA or requested by employers, employees, or their representatives; however, requests must be in writing. To counteract imminent dangers, OSHA must petition the district court to impose restrictions on the company or employer -- OSHA may not impose immediate restrictions itself. OSHA spends nearly 50 percent of its annual budget on federal inspection and enforcement activities (OSHA, 1987).

From 1973 to July, 1987, California conducted its own, OSHA-approved occupational safety and health program (Cal-OSHA) which covered both

private and public employees. Beginning July 1, 1987, however, authority over private workplaces and employees reverted to OSHA as a result of deletion of that portion of Cal-OSHA's budget allocated for enforcement in private workplaces; Cal-OSHA retained jurisdiction over State and local government workplaces. Two lower courts have ruled against the legality of the deletion of a portion of Cal-OSHA's budget and the matter is now before the State Supreme Court. In the meantime, Californians approved Proposition 97 in November, 1988, which requires the Governor and Cal-OSHA to appropriate sufficient funds and take whatever additional steps may be necessary to restore authority over private workplaces to the State. Thus, authority over private workplaces will revert back to Cal-OSHA once the State program can be re-established, which may occur before the end of 1989.

4. Department of Energy (DOE) and the Bonneville Power Administration (BPA)

DOE has the responsibility for promoting energy conservation, developing voluntary energy conservation standards for buildings and mandatory standards for appliances, and conducting research on the health and environmental hazards of energy-related pollutants. DOE, like other government agencies, is also responsible for assessing the environmental impacts of its programs (including IAQ) and implementing mitigation measures and monitoring programs if necessary. Although DOE does not have specific regulatory authority over IAQ, it has played a major role in IAQ research at the federal level. DOE's Bonneville Power Administration, discussed below, has also been a leader in research and regulatory efforts to address IAQ problems associated with energy conservation programs.

DOE has funded and administered several energy conservation programs having potential IAQ impacts. Since the late 1970's, DOE has implemented various weatherization and conservation programs for existing buildings, that have reduced building ventilation or allowed UFFI insulation. Examples of such programs include the Residential Conservation Service, the Weatherization Assistance Program, the Institutional Conservation Program, and the Energy Extension Service. Most of these programs are

carried out by utilities, local governments, and state governments. For proposed individual projects, DOE provides program review and guidelines for energy conservation aspects only and relies on state and local governments for environmental review and assessment of potential IAQ impacts.

DOE adopted interim energy conservation standards in 1988 for new federal building construction; these standards are voluntary for non-federal buildings. The federal residential standards require very tight construction, but also require the use of an air-to-air heat exchanger in the ventilating system to maintain IAQ by preventing ventilation reductions. The federal commercial standards are based on a proposed industry standard for commercial buildings. DOE must also conduct a demonstration study of the impact of the interim standards, report to Congress on the results, and promulgate final standards.

DOE is in the process of revising its appliance efficiency standards. Recently revised standards which require pilotless ignition in gas dryers and cold rinse cycles in clothes washers became effective in 1988; those which require pilotless ignition for kitchen ranges and ovens will become effective in 1990. Although not specifically targeted toward protection of IAQ, these revised standards should generally benefit IAQ. DOE's appliance efficiency standards supersede similar state standards, but states can apply for and receive a waiver. Also, it appears that states can regulate appliances for other (non-energy efficiency) purposes, such as for protection of IAQ.

DOE has carried out major efforts in IAQ research and public information. Since 1977, DOE has conducted research on infiltration, ventilation, the health effects of indoor pollution, radon, and effective mitigation measures. DOE has also provided significant public information on IAQ, including guidelines and handbooks on residential building design, combustion sources, and building system characteristics; information pamphlets; and environmental impact statements and environmental assessments for its various regulatory programs.

The Bonneville Power Administration (BPA) is an autonomous part of DOE which markets power for the Pacific Northwest and is responsible for implementing the regional power plan of the Northwest Power Planning Council. BPA's primary mandate is to provide reliable, cost-effective electrical energy to the Pacific Northwest Region, including a small part of northern California. BPA also sells surplus electricity to California. Since the early 1980's, BPA has aggressively pursued energy conservation opportunities and funded IAQ research and public information programs as well. BPA's commitment to IAQ protection and enhancement in conjunction with its energy conservation efforts has set significant precedents for the United States. This effort has been further enhanced by their cooperative work with the Northwest Power Planning Council and the States within the region.

BPA does not have specific authority to regulate IAQ. However, the current IAQ policy of both BPA and the Northwest Power Planning Council is not only to ensure that their conservation programs do not reduce ventilation rates below that achieved by current practices but also to emphasize source control as well as public information. Current BPA program specifications which affect IAQ are summarized below:

- o For existing houses which are weatherized, BPA has subsidized since 1984 proven radon mitigation measures in residences with measured radon levels over 5 pCi/l, especially for low-income residents. BPA has purchased and distributed 40,000 radon monitors for program participants.
- o For heating, ventilation, and air conditioning (HVAC) improvements in existing commercial buildings, BPA has required since 1984 demonstration of compliance with the consensus ventilation standard ASHRAE Standard 62-1981 (see Appendix X). For residential commercial buildings, BPA also requires radon monitoring of several floors.
- o For new residential buildings, BPA has required since 1986: low-formaldehyde emitting building products; radon monitoring using monitors supplied free of charge; preparation for radon source control measures; whole-house, continuously operating mechanical ventilation; outdoor air supplies for wood stoves; and distribution of IAQ information. If radon concentrations exceed 5 pCi/l, radon monitoring and mitigation are required if the builder does not choose to prepare the source control measures mentioned above.

- o For new commercial buildings, BPA has recommended since 1986 that mechanical ventilation systems meet the outdoor air flow rates specified in the most recent edition of the ASHRAE ventilation standard.

BPA is also very active in IAQ-related research and public information. Since 1982, BPA has spent several million dollars to study the implications of its energy conservation program for IAQ. The focus of BPA IAQ research has recently shifted from an emphasis on characterizing IAQ and its related health effects to an emphasis on developing better mitigation techniques. BPA produces and disseminates a large amount of diverse information on IAQ, including environmental impact reviews, research reports, literature reviews, contractor training videos, homeowners handbooks, and fact sheets, pamphlets and guidelines for the general public. In 1988, BPA also worked with the State of Oregon to help develop a draft radon ordinance.

5. Department of Housing and Urban Development (HUD)

The federal Department of Housing and Urban Development is responsible for achieving the National Housing Goal of "a decent home and a suitable living area environment for every American family" (42 USC 1441). The basic mission of HUD is to provide adequate housing, promote community and economic development of urban areas, and eliminate discrimination in housing markets. HUD has several mandated responsibilities that directly involve IAQ: 1) promulgation and enforcement of the Manufactured Housing Construction and Safety Standards (single-family mobilehomes), which currently include formaldehyde emission standards and ventilation requirements; 2) development of an indoor radon policy; 3) incorporation of future EPA radon guidelines, standards, information, and mitigation measures into HUD housing programs; 4) research, with EPA, on the assessment and mitigation of radon and other indoor pollution problems in new construction; and 5) development of mitigation measures for lead-based paint.

Under the Housing and Community Development Act of 1974 HUD has the authority to establish appropriate manufactured home (mobile home) construction and safety standards. These standards must be reasonable and

meet the "highest standards of protection". However, HUD must also consider cost impacts, pertinent state and local laws, and recommendations of the U.S. Consumer Product Safety Commission. In 1984 HUD established formaldehyde emission standards for plywood and particleboard used in mobilehomes: 0.2 ppm and 0.3 ppm (test chamber concentrations), respectively, to maintain indoor air concentrations of formaldehyde in mobile homes below 0.4 ppm [24 CFR 3280.309(a)]. HUD also required the provision of ventilation options, including a mechanical system (a fresh air inlet installed with the heating system), a passive system (operable windows and doors), or a combination of the two. Furthermore, HUD required the buyer to be provided with a health hazard notification and written information on the capacity and installation of the mechanical ventilation system.

Once promulgated, HUD mobile home standards preempt any existing or future standards of state or local governments that apply to the same aspect of mobile home performance (Sec. 604[d]). However, it is unclear whether HUD's formaldehyde emission standards for materials in mobile homes regulate the same performance aspect as, and thus preempt, state standards for formaldehyde air concentrations in mobile homes. HUD lacks the authority to preempt state standards for modular, factory-built, or other types of housing which may also contain large amounts of formaldehyde-emitting wood products and other pollutant-emitting building materials.

HUD has addressed radon problems in some parts of the country since the 1970's by requiring radon testing and/or mitigation for HUD--assisted housing, or by rejecting mortgage insurance applications. In 1986, HUD received an explicit mandate through Title IV of the Superfund Authorization and Renewal Act (SARA) to conduct research and develop mitigation measures with EPA. Amendments to the McKinney Homeless Assistance Act of 1988 further required HUD to: develop and recommend to Congress a policy for dealing with radon in HUD programs; enter into a Memorandum of Understanding with EPA; and utilize any guidelines,

standards, or mitigation measures developed in the future by EPA in carrying out HUD housing programs. HUD is in the process of implementing these requirements.

Although lead poisoning occurs in children primarily through ingestion, significant inhalation exposures in children and adults may result as paint surfaces age and produce fine particles and when old paint is removed by sanding, blasting, or similar methods. The Lead-Based Paint Poisoning Prevention Act of 1971 (LPPPA) and subsequent legislation required HUD to study, demonstrate, and establish procedures for eliminating hazards due to lead-based paint in its mortgage insurance and other housing assistance programs. Congress recently amended the LPPPA under the McKinney Homeless Assistance Act of 1988 to temporarily suspend HUD's development of mitigation procedures and to require HUD to conduct a demonstration program and develop health and safety guidelines for the removal of lead-based paint. The guidelines must be based on cost-efficiency as well. To implement the new legislation, HUD will conduct a national demonstration program for safe and cost-effective removal of lead-based paint and report to Congress. Also, a cost estimate for a national abatement program, and a comprehensive and workable abatement plan are due to Congress in September of 1990.

HUD also has other responsibilities that affect IAQ indirectly. These responsibilities include: development of Minimum Property Standards (MPS) for housing financed by HUD; implementation of energy conservation programs; and environmental review of housing assistance and development programs. The MPS are construction and rehabilitation standards which include specifications regarding what construction materials and methods are acceptable. The Farmers Home Administration and the Veteran's Administration also use the MPS in their housing assistance programs. The MPS can also address issues related to indoor air quality such as ventilation, appliances, and insulation materials. Thus far, it appears that HUD has specifically addressed indoor air quality through its MPS, energy conservation, or environmental review programs in only a few cases.

The liability of federal housing agencies such as HUD for environmental hazards, including indoor air pollution, has recently become a major legal issue. Recent court decisions have required the federal government as landlord to correct or eliminate problems of habitability. So far, the only indoor pollutant addressed specifically has been lead-based paint. However, HUD is currently defending a suit for alleged exposure to asbestos in a HUD-owned public housing project (GAO, 1988a). Future similar litigation related to radon and other indoor pollutant exposures may follow. In response to liability concerns, two private-sector financial institutions -- the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac) -- have recently developed guidelines or proposals for managing environmental hazards including indoor pollution.

6. Department of Health and Human Services (DHHS)

The Department of Health and Human Services is the Cabinet-level department that addresses most directly the health and human welfare needs of American citizens, and consequently is one of the four co-chairs of the federal interagency Committee on Indoor Air Quality. DHHS has no regulatory authority over indoor air quality. However, through many of its agencies, DHHS carries out important activities which can directly affect IAQ, including the development of recommended exposure limits for workplace environments, field investigations of indoor air quality problems, intramural and extramural research related to the health effects of indoor pollutants, assessments and recommendations regarding cigarette smoking, and regulation of food and drug products.

The National Institute for Occupational Safety and Health (NIOSH), within DHHS's Centers for Disease Control, conducts research on occupational health and safety hazards and recommends workplace standards, including air quality standards, to OSHA. NIOSH has evaluated over 150 potentially hazardous substances or practices (NIOSH, 1988) and has produced 129 Criteria Documents which serve as the primary transmittal documents for recommended standards to OSHA and to the Mine Safety and Health Administration. NIOSH Recommended Exposure Limits, or RELs, are

based on worker health protection considerations and do not specifically consider technological or economic feasibility, although in some cases the technological feasibility of a proposed standard has been assessed (NIOSH, 1987).

NIOSH has also conducted about 500 indoor air quality investigations in a variety of office building environments since 1971 (Crandall, 1988) under the Health Hazard Evaluation Program, a program of voluntary workplace inspections provided by NIOSH upon request. The most frequent problem found (52 percent of the cases) was inadequate ventilation. Other problems encountered included contamination from indoor sources (16 percent), contamination from outdoor sources (10 percent), contamination from building fabric (4 percent) and microbial contamination (5 percent).

DHHS's Public Health Service has developed a national strategy for achieving further improvements in the health of Americans, which includes as one of its major objectives the reduction of the percentage of the smoking population in all age groups. The current Surgeon General, Dr. C. Everett Koop, has emphasized the hazards that result from passive exposure to tobacco smoke (lung cancer, and increased respiratory disease in infants), and has declared nicotine an addictive substance (Surgeon General, 1986; Surgeon General, 1988). Dr. Koop's aggressive position regarding prevention of tobacco smoke-induced disease has frequently been cited in support of increased restrictions on smoking in both governmental and private workplaces and public buildings.

The Food and Drug Administration's (FDA) mandate is to protect American consumers from impure or misbranded cosmetics, foods, drugs and medical devices. The FDA enforces the Federal Food, Drug and Cosmetic Act (FDCA) and related legislation which has established strict testing guidelines for drugs and medical devices. However, there are no similar health testing requirements for cosmetic products (see Appendix G) despite the overwhelming volume of these products used every day and their potential adverse health effects.

FDA's authority and involvement in IAQ is indirect in all areas except one. It does have direct authority to regulate ozone which is intentionally or incidentally emitted from medical devices, and has set an indoor air quality standard for ozone of 0.05 ppm for areas where such devices are used. FDA also has an indirect effect on IAQ through its enforcement of the FDCA, through its public education campaigns, and through its research projects.

A number of other agencies within DHHS, particularly the National Institutes of Health, conduct significant research related to IAQ, although none has a specific IAQ mandate. Research related to IAQ currently being conducted includes studies of the health risks of radon exposure and passive smoking; the health effects of gases, particles and toxic air pollutants found in indoor environments; the allergenicity of airborne particulates; and microbial pollutants. Major epidemiological studies which include assessment of indoor pollutant exposures have also been funded, such as the Harvard Six Cities Study and the National Health and Nutritional Examination Survey.

7. Department of Transportation (DOT)

The Department of Transportation (Appendix H) has authority over the IAQ of enclosed transportation-related spaces such as aircraft cabins, merchant ships, U.S. Coast Guard vessels, buses and highway tunnels. However, other than for aircraft cabins (see below), there is no statutory requirement for DOT to promulgate air quality regulations in these areas. DOT follows the standards and guidelines set by OSHA and EPA for IAQ of enclosed spaces under its jurisdiction.

DOT exercises air quality control of transport-related interiors through several of its subordinate agencies. The Federal Aviation Administration (FAA) has set standards for ozone and carbon dioxide in aircraft cabins. Recently, FAA developed regulations (as required by Congress in Public Law 100-202) to ban smoking on scheduled domestic airline flights of two hours or less duration. Those regulations became

effective on April 23, 1988. The ban does not include the cockpit area, and chartered flights are not covered.

8. Other Federal Agencies

A number of other federal agencies can and do affect IAQ in limited indoor environments or have conducted limited research related to IAQ. The Department of Defense, for example (see Appendix I), has banned or restricted cigarette smoking in nearly all of its facilities, and the Air Force, Army, and Navy have undertaken studies to assess and mitigate potential radon problems at bases both within and outside of the United States. The National Aeronautics and Space Administration (Appendix J) has studied volatile organic chemical emissions from about 3500 materials used in spacecraft. Some of these materials are currently used for other (indoor) purposes as well, or will eventually find their way into general public use as other materials have done. The National Institute of Standards and Technology (Appendix K--formerly the National Bureau of Standards), has also conducted significant research related to IAQ, including studies to develop a standard measurement method for radon concentrations and an indoor air pollution concentration model. These agencies and a few other federal agencies not discussed in this report, such as the General Services Administration and the Federal Trade Commission, may play an increasing role in IAQ research and management in the future.

B. STATE AGENCIES

In California, no formal State plan or comprehensive process has been developed to address indoor air quality problems. Since 1983, the Department of Health Services (DHS) has had the responsibility to conduct IAQ research and to coordinate the State's response to indoor air problems (see Appendix L). DHS has conducted significant research, has undertaken a number of public education activities, and has issued an indoor air quality guideline for formaldehyde. DHS also chairs the California Indoor Air Quality Interagency Working Group (IWG), an informal group of State agency representatives and others who meet at least quarterly to discuss

IAQ issues. DHS has stated their intent to pursue or request regulatory actions on several indoor air problems in the future (Kizer, 1988), but DHS has not yet established a mechanism for developing, implementing, and enforcing indoor air quality regulations, and to date has taken no steps in this direction.

Two significant mitigation measures to specifically address IAQ have been promulgated by State agencies. The sale and installation of urea formaldehyde foam insulation was effectively banned by CEC in 1982. In 1986, the Occupational Safety and Health Standards Board approved the Minimum Building Ventilation Standard; however, it only applies to workplaces under Cal-OSHA's jurisdiction and provides for only limited enforcement.

1. Department of Health Services (DHS) and
California IAQ Interagency Working Group (IWG)

The general mandate of the Department of Health Services is to protect public health. In 1982, legislation and a budget augmentation were approved which together established an indoor air quality program within DHS's Air and Industrial Hygiene Laboratory. The new mandate required DHS to "coordinate efforts to assess, protect, and enhance indoor environmental quality" and to "conduct and promote the coordination of research, investigations, experiments, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, and control of indoor pollution" (HSC Section 426). Dwellings, schools, offices, and public buildings were included under DHS's purview, but industrial working environments were specifically excluded. Explicit regulatory authority over indoor air quality was not included in the new mandate.

Other sections of the HSC also provide DHS with specific authority related to indoor air quality. Section 18615.5 requires DHS to "conduct a toxic research and information program," part of which is to "be devoted to the development of standard methods for measuring indoor air quality, the determination of the source of contaminants, and the making of recommendations for laws or regulations, where appropriate." Also, DHS

has specific regulatory authority over asbestos. HSC Section 25910.5 directs DHS to "adopt regulations prohibiting or regulating the use of asbestos...if the state department finds that such use is dangerous to the public health." DHS also has very limited authority indirectly related to indoor air quality through the Sherman Food, Drug, and Cosmetic Law (HSC Sec. 26000 et seq.), the California Hazardous Substances Act (HSC Sec. 28740 et seq.), and the California Safe Drinking Water Act (HSC Sec. 4010 et seq.).

The Department's Indoor Air Quality Program (IAQP) currently consists of eight permanent technical staff. Estimated program expenditures for FY 1987-88 were \$844,000, nearly half of which was appropriated by the Legislature for a study of asbestos in public buildings. Program expenditures for FY 1988-89 are projected to be about \$516,000 (Hill, 1988).

In terms of regulating or recommending regulations for indoor air quality protection, DHS has made two notable efforts. In 1983 DHS recommended an air quality standard of 0.05 ppm for formaldehyde in mobile homes. However, the standard was not promulgated by the Department of Housing and Community Development (HCD), which instead developed a material emission standard which was subsequently pre-empted by a federal emission standard. DHS also served as chair of the advisory committee convened by Cal-OSHA to develop the Minimum Building Ventilation Standard.

The DHS IAQP has focused on research and public education as its major areas of involvement for two reasons. First, the legislative mandates cited above emphasize research and education, and second, at the time of the inception of the program, little was known about the extent of the indoor air quality problem, and therefore the program was viewed at its inception principally as a means to fill that knowledge gap.

The IAQP has carried out extensive research on the "causes, effects, extent, prevention, and control of indoor pollution." In 1984-85 the program conducted a major statewide survey of formaldehyde and nitrogen dioxide concentrations in mobile homes. Currently, DHS is conducting

several large-scale field surveys. The first is a study of asbestos in 260 public buildings throughout California. This study was mandated by the legislature in 1986. The second is a study of radon concentrations in 440 California residences funded by the Air Resources Board and supplemented with personnel and equipment from DHS. The third is a detailed study on the effectiveness of "baking out" new or renovated buildings to reduce occupant exposures to toxic air contaminants. The DHS IAQP is also conducting numerous other studies including investigations of complaint buildings, studies of microbial contamination in evaporative coolers, and determinants of ventilation patterns in residences. IAQP staff also served on a scientific advisory panel directing a 5-county survey of radon concentrations in Southern California carried out by the Los Angeles Times, and the program is currently conducting a radon survey in 1000 homes in Ventura County and portions of northern Los Angeles County.

DHS chairs the Interagency Working Group (IWG), which is an affiliation of representatives from state, federal, and local agencies and private organizations who meet at least quarterly to discuss indoor air quality issues and needs. The IWG has no formal authority; rather, its purpose is to provide a forum for identification of specific indoor air quality issues and problems and possible ways of addressing them, and to encourage coordination of indoor air quality activities among the participating agencies. Several years after the inception of the IWG, three committees -- the Public Education Committee, the Building Complaints Committee, and the Policy and Legislation Committee -- were formed. Through the committees, and with extensive DHS effort, several IAQ fact sheets and an Assistance Directory, a booklet which lists the contact persons for all of the agencies and organizations in California that may be able to advise people regarding indoor air quality problems, were developed and distributed. For various reasons, including lack of interest on the part of some IWG members, none of the three committees is currently active. The IWG has no specific goals or objectives at this time.

DHS has undertaken other coordination activities within the state, including serving as chair of two asbestos task forces and advising state and local agency staff regarding indoor air quality. DHS has also cooperated with federal agencies and quasi-governmental groups in a variety of research projects and has served on various advisory panels which directly or indirectly involve indoor air quality. Details of these activities are provided in Appendix L.

DHS has not issued a formal program plan which describes its future efforts to address indoor air quality. Regulatory and other actions appear warranted to protect the public from adverse exposures to pollutants indoors. DHS has stated their intent to pursue or request regulatory actions on several indoor air problems in the future (Kizer, 1988). However, DHS has not yet established a clear mechanism for developing, implementing, and enforcing indoor air quality regulations, and to date has taken no significant steps in this direction (see Appendix L).

2. Air Resources Board (ARB)

The California Air Resources Board (ARB) coordinates the federal air quality program in California and sets State ambient (outdoor) air quality standards and motor vehicle emission standards. The ARB also enforces the State motor vehicle emission standards and has oversight authority for the implementation of control measures by local Air Quality Management Districts and Air Pollution Control Districts to limit emissions from non-vehicular (stationary) sources of pollutants such as industrial plants.

The ARB has research and exposure assessment authority related to indoor air quality but does not have direct regulatory authority over indoor air quality (Jennings, 1986). The ARB's authority to conduct research related to indoor air quality primarily stems from its very broad authority to research "air pollution" (HSC Sec. 39700 et seq.), including but not expressly limited to 12 specific research areas such as "effects of air pollution on human health and comfort" [HSC Sec. 39701(a)(5)] and "the identification of knowledge gaps" [HSC Sec. 39701(c)]. The ARB was

directed to conduct indoor exposure assessments through Assembly Bill 3052, Tanner (HSC Sec. 39660.5) which requires the ARB to assess indoor exposures as well as outdoor exposures in evaluating the level of potential human exposure to pollutants addressed through the Board's Toxic Air Contaminants Program. A subsequent bill, AB 3343 (Tanner, 1988), requires the ARB to quantify the relative contributions of indoor and outdoor air exposures to the total exposure [HSC Sec. 39660.5(d)].

The ARB has interpreted the authority of the districts and ARB over stationary sources as extending only to the protection of outdoor air quality. However, the ARB has maintained that district and ARB authority to regulate "air pollutants", defined as discharges "into the atmosphere" (HSC Sec. 39013), permits local districts to control indoor emissions to the extent that the purpose is ultimately to reduce outdoor air pollution, and that the ARB has oversight authority in this area as well (Jennings, 1986). Recent legislation, AB 2595 (Sher), commonly referred to as the California Clean Air Act of 1988, gives the ARB related specific authority with regard to a wide range of consumer products. HSC Sec. 41712(a) now directs the Board to "adopt regulations to achieve the maximum feasible reduction in reactive organic compounds emitted by consumer products, if the state board determines that adequate data exists for it to adopt the regulations." HSC Sec. 41712(c) defines "consumer product" as a "chemically formulated product used by household and institutional consumers, including, but not limited to, detergents; cleaning compounds; polishes; floor finishes; cosmetics; personal care products; home, lawn, and garden products; disinfectants; sanitizers; and automotive specialty products..." Thus, the ARB may regulate certain indoor sources of pollutants to protect and enhance outdoor, but not necessarily indoor, air quality.

Because the California Clean Air Act only recently became effective, no actions have yet been taken by the ARB specifically to reduce emissions of reactive organic compounds from consumer products. However, other ARB regulatory efforts can indirectly affect indoor air quality. Motor vehicle emission standards and enforcement actions, for example, reduce the concentrations of pollutants along roadways and in communities, and

thus reduce the concentrations of pollutants which might infiltrate into buildings under conditions of normal indoor/outdoor air exchange.

Pollutants regulated by the ARB through ambient or emission standards include carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, lead, particles, sulfates, vinyl chloride, non-methane hydrocarbons, hydrogen sulfide, and visibility reducing particles. In addition, through its Toxic Air Contaminants Program, the ARB identifies toxic pollutants and develops control measures to reduce their emissions (HSC Sec. 39650 et seq.). Pollutants identified as toxic air contaminants thus far include asbestos, benzene, cadmium, chlorinated dibenzodioxins and dibenzofurans (15 species), chromium (VI), ethylene dibromide, ethylene dichloride, carbon tetrachloride, and ethylene oxide.

In February, 1988, the Board endorsed the ARB Indoor Air Quality/Personal Exposure Five-Year Study Plan (Plan, ARB, 1988), which was developed in part to obtain data needed to produce the indoor exposure assessments required for the Board's Toxic Air Contaminants Program. Several studies targeted toward obtaining the needed information have been funded by the ARB. These studies include:

- o activity pattern studies of California adults and children to obtain representative information regarding the time Californians spend in various activities and locations, especially those likely to result in exposure to air pollutants;
- o joint EPA/ARB Total Exposure Assessment Methodology (TEAM) studies in California, which have involved measuring personal, indoor, and outdoor concentrations of vapor-phase organic compounds, small particles (PM10 and PM 2.5), and several toxic substances which are of special interest to the ARB;
- o a survey of radon concentrations in about 440 homes statewide;
- o a pilot study to develop methods to measure indoor concentrations of polynuclear aromatic hydrocarbons (PAHs), a large group of organic compounds, many of which are carcinogenic or mutagenic; and
- o a pilot PM10 study to develop the methods necessary to measure and assess personal, indoor, and outdoor exposures to PM10.

The ARB has also undertaken a number of other indoor air quality related activities. ARB staff prepared a Briefing Paper (ARB, 1987) for the Board in May, 1987 which included information on sources and concentrations of indoor pollutants, factors which affect indoor pollutant levels, techniques for controlling indoor pollutants, and governmental activities related to indoor pollution. ARB staff also actively participate in the California Indoor Air Quality Interagency Working Group (IWG-see Appendix L). Increased staff interaction with the IWG is anticipated in the future to help determine appropriate actions which government agencies can take to prevent or mitigate exposures to pollutants indoors. The ARB has also revised its own smoking policy to fully prohibit smoking in all ARB-owned or -leased buildings and in ARB vehicles.

3. Cal-OSHA -- the Department of Industrial Relations and the Occupational Safety and Health Standards Board

California's occupational safety and health program, commonly referred to as Cal-OSHA, is carried out under the administration of the Department of Industrial Relations (DIR). Major program elements include (DIR, 1988; Cal-OSHA, 1985):

- o the Division of Occupational Safety and Health (DOSH), which enforces State occupational safety and health standards and regulations;
- o the Cal-OSHA Appeals Board, which finds on the facts concerning citations, special orders, penalties, and abatement dates that are in appeal, and resolves issues that are in dispute;
- o the Cal-OSHA Consultation Service, which consists of safety engineers and industrial hygienists who provide free, on-site consultation services to employers as well as advice and information regarding occupational safety and health to employers and employee groups, but are not involved with enforcement activities;
- o the Occupational Safety and Health Standards Board (Standards Board), which adopts, amends, or repeals safety and health standards and acts on applications for variances; and
- o the Division of Labor Statistics and Research, which compiles and publishes annual statistics on occupational injuries and illnesses.

Cal-OSHA received initial program approval from federal OSHA in 1973 and certification in 1977. It is unclear why final approval, the third step in the federally-required state program approval process (see Appendix D), was never achieved. However, as a certified state program until July, 1987, Cal-OSHA fully administered all aspects of standard-setting, enforcement, and other program functions in the State, and had authority over both public and private sector employees except for household domestic service employees and federal employees covered under federal OSHA and other federal agencies.

As of July 1, 1987, however, enforcement authority over private sector workplaces (covering about 9.5 million private sector employees [GAO, 1988b]) was returned to federal OSHA as a result of an administrative deletion of portions of Cal-OSHA's budget, including funding allocated for oversight of private workplaces. Cal-OSHA retained jurisdiction over State and local government employees and workplaces. One lower court has ruled against the legality of the deletion of a portion of Cal-OSHA's budget and the matter is now before the State Supreme Court (DIR, 1988). In the meantime, Californians approved Proposition 97 in November, 1988, which requires the Governor and Cal-OSHA to appropriate sufficient funds and take whatever additional steps may be necessary to restore authority over private workplaces to the State. Currently, however, federal OSHA retains enforcement authority over private sector employees and workplaces, but return of that authority is anticipated when the State program again meets federal requirements, which could occur as early as summer, 1989.

The primary regulatory authority of Cal-OSHA which affects indoor air quality is the authority to develop, promulgate, and enforce air quality, ventilation, and other standards for the workplace. Under California Labor Code (CLC) Section 142.3, the Standards Board is the only agency in the State authorized to adopt occupational safety and health standards (Jablonsky, 1988). Like federal OSHA, the Standards Board relies heavily on the Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH--see Appendix X) in setting health-based standards for specific chemical substances. The Standards

Board must adopt standards at least as effective in protecting worker health as the federal standards within six months of the effective dates of federal standards. The Standards Board may also adopt emergency standards under certain conditions, and is required by State statute to adopt standards covering specific issues such as the use of carcinogens in the workplace, workers' right-to-know about hazardous substances in the workplace, and hazardous substance removal work. It is the policy of the Standards Board that all regulations be enforceable, reasonable, understandable, and contribute directly to the safety and health of California employees (Standards Board, 1988).

The Standards Board has adopted many standards and regulations that affect workers' exposures to indoor air pollutants. Article 107 of Title 8 of the California Code of Regulations (CCR) provides minimum standards for the prevention of harmful exposure of employees to dusts, fumes, mists, vapors, and gases. Section 5155 of Title 8 CCR lists permissible exposure limits for over 530 chemical contaminants; excursion (short-term) and ceiling exposure limits for 28 pollutants; and permissible exposure limits for mineral dusts, including nuisance particulates. The State's most recent update of exposure limits was largely based on the 1985 TLVs of the ACGIH (Schaefer, 1987).

Cal-OSHA's general requirements for ventilation systems are primarily safety oriented but include requirements for adequate air flow to remove dusts, fumes, mists, vapors and gases and to convey them to suitable points of disposal. Specific requirements for ventilation and personal protective equipment (such as respirators) also are delineated for certain activities such as welding, grinding, and spray coating (CCR Sections 5150 to 5154). For the majority of California's workers who work indoors, however, the Minimum Building Ventilation Standard (CCR Section 5142) perhaps offers the greatest protection of their air quality.

The Minimum Building Ventilation Standard became effective in February, 1987. The Standard was developed in response to Petition No. 151 from the International Brotherhood Electrical Workers, Local Union 1245. The standard addresses operation, inspection, and maintenance of mechanically

driven HVAC systems, and includes the following provisions under General Industry Safety Order 5142 (see Appendix N for full text):

- (1) The HVAC system shall be maintained and operated to provide at least the quantity of outdoor air required by the State Building Standards Code, Title 24, Part 2, California Administrative Code, in effect at the time the building permit was issued.
- (2) The HVAC system shall be operated continuously during working hours except during scheduled maintenance and emergency repairs and other specified periods.
- (3) The HVAC system shall be inspected at least annually, and problems found during these inspections shall be corrected within a reasonable time.

Cal-OSHA's Minimum Building Ventilation Standard is the first substantive effort to assure that ventilation systems are properly operated and maintained; building standards generally have only addressed design and construction, and not operation and maintenance, of building components.

The Standards Board faces a particularly sizeable task in restoring certain aspects of the State program so that it again meets federal requirements for independent status. As mentioned, federal law requires that, within six months of promulgation of new federal occupational safety and health standards, states with approved state programs must promulgate comparable standards that are at least as effective as the new federal standards. In recent years, federal OSHA has promulgated an unprecedented number of new workplace standards, primarily as a result of the sweeping revisions made in January, 1989 to its air contaminant standards. Appropriate hearings and rulemaking procedures will be necessary to promulgate new State standards or amend existing ones where State standards comparable to the new federal standards do not exist (Jablonsky, 1989).

To enforce standards and safety and health regulations, Cal-OSHA may conduct inspections; issue citations, notices and orders; assess penalties; require permits; and grant variances. Through 1987, Cal-OSHA has spent approximately 60-66 percent of its budget each year on enforcement activities (DIR, 1986; DIR, 1988). Safety inspections

constitute the largest proportion of enforcement activities each year (17,171 in 1986), but health inspections (including laboratory services) nonetheless account for about 25 percent of annual expenditures (3,520 health inspections in 1986).

A DOSH investigator issues a citation which sets a reasonable time for abatement when he believes that an employer has violated any standard, rule, order, or regulation. Penalties are always issued for serious, repeated, and willful violations and certain other violations. If an imminent hazard is found at a worksite, a DOSH inspector may shut down work immediately by issuing an "order prohibiting use."

In addition to setting standards and enforcing health and safety standards and regulations, exercise of other Cal-OSHA authorities can also affect indoor air pollutant exposures in the workplace. Some of those authorities include implementation of the Hazardous Substances Information and Training Act of 1980, implementation of the Occupational Carcinogens Control Act of 1976, provision of consultation services, and development of voluntary protection programs. All of these are discussed further in Appendix N.

4. California Energy Commission (CEC)

The general mandate of the California Energy Commission is to ensure a reliable energy supply in a manner consistent with protecting the State's environment and enhancing its economy. The CEC's main impact on IAQ results from energy conservation standards for new buildings, appliances, and insulation materials. Under the Warren-Alquist Act and the California Environmental Quality Act (CEQA), CEC has the responsibility to consider and mitigate the environmental impacts of its discretionary activities, which include the development of energy conservation standards, grant and loan programs, and plans and policies.

CEC lacks specific authority concerning IAQ, except for a few limited cases. CEC has specific authority to regulate UFFI, a source of indoor formaldehyde emissions. CEC also regulates the design and

construction of new buildings and appliances for energy-related purposes. However, CEC lacks the authority to regulate the operation and maintenance of buildings and appliances, factors which are among the most important determinants of IAQ. Recently, CEC received specific legislative mandates to fund a pilot field study of IAQ in new residences and to consider the IAQ impacts of its existing and proposed building standards.

Although CEC has only limited regulatory authority over IAQ and no formally adopted IAQ policy, it has made some pioneering efforts in California to protect IAQ. Through the CEQA process, it has assessed potential IAQ impacts of some of its energy conservation standards. It was one of the first government agencies to effectively ban UFFI, to require air-to-air heat exchangers in very tight houses, to address ventilation effectiveness in pollutant removal, and to provide public information on IAQ. However, CEC has often expressed its belief that emphasis should be placed on controlling sources of indoor pollution, not on curtailing implementation of sensible energy conservation measures.

The major CEC activities which have involved IAQ are summarized below:

- o In 1978, CEC prohibited the sale of gas stoves equipped with gas pilot lights. This action both saved energy and reduced indoor emissions from the most common unvented combustion appliance in California.
- o CEC adopted the 1978 Nonresidential Building Standards for energy efficiency. These standards increased ventilation rates in smoking areas but may have inadvertently allowed the permitting of ventilation systems that provide a lower minimum ventilation rate than is required by the standards.
- o In 1982, CEC listed UFFI as unsafe and effectively prohibited its sale and installation in California.
- o Unlike earlier standards, CEC's 1985 Office Standards, which became mandatory in 1987, did not allow lower ventilation rates for nonsmoking areas. In addition, the new standards improved and clarified ventilation requirements for air distribution, filtration, and recirculation. These ventilation requirements were later incorporated into new standards for retail and wholesale stores as well.
- o In 1985, CEC published and widely distributed the Energy Efficiency Manual, which included an IAQ appendix with up to date guidelines and a recommended reading list for building designers and engineers.

Completed CEC research on IAQ to date is limited to two small studies funded in 1980. CEC issued a contract in 1987 for a pilot field study to evaluate the impacts of its residential building standards on energy savings, cost effectiveness, and IAQ. In addition, CEC has issued a \$50,000 contract to update the Energy Efficiency Manual.

5. Department of Consumer Affairs (DCA)

The Department of Consumer Affairs is the State agency responsible for promoting consumerism and protecting the public from deceptive and fraudulent business practices. Within the DCA are various boards, bureaus, programs, and commissions (agencies). These agencies can license, register, or otherwise certify ("license") practitioners of a particular occupation, generally require applicants to meet minimum qualifications and levels of competence, investigate public complaints or grievances, institute disciplinary actions against licensees, conduct periodic compliance checks of licensees, and require that the license number from the licensing agency be included in any advertising or soliciting. Licensing boards under DCA's jurisdiction have the authority to license architects, engineers, contractors, cosmetologists, pesticide applicators, and others whose activities affect IAQ. However, DCA does not currently include licensing agencies for some other professions that can create or resolve IAQ problems, such as IAQ testing companies and consultants. Also, DCA's licensing agencies can only enforce compliance of licensed professionals or businesses with existing laws and regulations, of which few contain specific IAQ-related requirements.

Unlike the federal CPSC, DCA does not have authority to ban or require modifications to consumer products which present health or safety hazards. However, DCA can propose or recommend legislation to address such problems, although it has not yet proposed any legislation to specifically address any IAQ health hazard. DCA can also conduct research and provide information to consumers.

DCA's Division of Consumer Services and Legislation worked with state and local government agencies and utilities in 1978-1980 to address

IAQ problems associated with the use of UFFI in energy conservation programs. In 1982, the Division produced Clean Your Room! A Compendium on Indoor Air Pollution (DCA, 1982). The report was the first comprehensive review of indoor pollution by a State agency and included recommendations for actions by state and federal government. The Division has also issued consumer warnings regarding, and sought compliance with, the State law which bans the sale or offering for sale of unvented combustion heaters designed for residential use.

DCA's Bureau of Home Furnishings and Thermal Insulation (BHFTI) is responsible for promulgating and enforcing regulations pertaining to: the contents and safety of home furnishings, standards for building insulation sold in California, and registration of dry cleaning plants in California. All of these can produce indoor pollutants, e.g., formaldehyde, plasticizers, solvents, and odors. However, BHFTI has only limited authority to address IAQ problems in these areas and only registers dry cleaning plants; it has no duties regarding the safety of these plants. Furthermore, BHFTI does not have the authority to regulate either carpets or drapes used in homes or the in-home cleaning of home furnishings.

BHFTI develops and enforces sanitization (formerly sterilization) requirements and labeling requirements for new and used furnishings, including bedding, under its jurisdiction. BHFTI also establishes insulation material standards related to the safety (flammability) and thermal performance of the insulation material during application and use, and currently enforces the CEC insulation material standards, which include odor and formaldehyde emission standards (see Appendix O). Additionally, BHFTI registers dry cleaning plants and obtains proof of financial responsibility and information on the handling of toxic wastes and the type of dry cleaning solvents used. BHFTI has not regulated indoor emissions of pollutants from products which it regulates for the purpose of reducing indoor exposures, and it does not appear to have the authority to do so.

The Board of Cosmetology (BOC) licenses and regulates cosmetologists, cosmetology schools and establishments, and other branches

of cosmetology such as manicuring and electrology. Further, the BOC conducts inspections and can suspend or revoke licenses to practice and to operate a business. The BOC also responds to consumer complaints. However, the BOC has no authority to ban or restrict the use of potentially harmful cosmetology products.

Recently, BOC staff prepared a document which details the health hazards of substances found in hair, nail and skin products. This document, titled "Hazardous Substances in the Cosmetology Workplace", was presented to the BOC in November, 1988, and may result in upgrading of educational requirements for cosmetology students, development of a public education campaign, publication of the report's findings in a cosmetology newsletter, or initiation of a legislative task force.

The Structural Pest Control Board (SPCB) tests all structural pest control applicators, requires certification or licensing of all structural pest control applicators and businesses, and requires continuing education of licensees. Further, SPCB can cite applicators and businesses, and can suspend or revoke licenses. SPCB also responds to consumer complaints, and enforces other regulations which can affect exposures to pesticides, such as requirements to notify building occupants in writing prior to pesticide spraying.

Several other DCA boards conduct activities which may indirectly affect IAQ. The Board of Registration for Professional Engineers and Land Surveyors examines, licenses, and registers engineers, including mechanical engineers who design and construct HVAC systems for buildings; chemical engineers and manufacturing engineers who design and manufacture building materials; and soil engineers who may have to reduce the transport of pollutants from the soil to the indoors. The Contractors State Licensing Board (CSLB) licenses and regulates general building contractors as well as specialty contractors who provide services that can affect IAQ, including: asbestos mitigation; heating, ventilating, and air conditioning; insulation; flooring and floor covering; painting and decorating; cabinet and mill work; and general manufactured housing. The license exams developed by CSLB address occupational safety and health

issues but do not specifically address IAQ. However, exams for some licenses, such as the asbestos abatement license and the heating, ventilation, and air conditioning license, indirectly address IAQ through testing on applicable information and regulations for asbestos or building ventilation, respectively. The Board of Architectural Examiners (BAE) regulates practicing architects and building designers who design building systems, including HVAC systems, and prepare specifications for building materials to be used. Other DCA boards that regulate services that can affect IAQ include the Bureau of Electronic and Appliance Repair and the Board of Registration for Geologists and Geophysicists.

6. Department of Housing and Community Development (HCD)

HCD is one of several State agencies with significant authority to adopt and enforce building standards (HCD, 1988). In 1975, the California Energy Commission became responsible for energy conservation standards in new buildings, including ventilation design requirements, leaving HCD the responsibility for building standards related to health and safety for housing. HCD has the authority to: 1) adopt and enforce residential building regulations; 2) enforce (but not adopt) standards for the construction of manufactured housing; 3) administer various housing development and rehabilitation programs, with particular attention to meeting the needs of low income and other disadvantaged groups (Deukmejian, 1988); and 4) conduct research and develop State housing policy. HCD provides both financial assistance and technical assistance for housing development, and coordinates local, State and federal housing assistance efforts throughout California. HCD is also required to submit a Statewide Housing Plan to the Legislature every five years for adoption and to update it bi-annually (HSC Sec. 50451 et. seq.).

HCD has no direct authority to regulate indoor air quality (Reed, 1988) but has indirect or implicit authority to protect indoor air quality. Through its building standards and housing assistance programs, HCD regulates aspects of housing that directly affect IAQ, such as combustion appliance venting, building materials, building ventilation, and residential hazardous materials. However, HCD's 1988 revision of the

State building standards did not address a number of indoor air quality concerns related to these areas (see Appendix Q). HCD also enforces federal standards for lead paint and asbestos-containing materials in federally funded housing assistance programs and is responsible for enforcing federal (HUD) construction standards for manufactured housing, which include requirements regarding formaldehyde emissions and ventilation. However, HCD cannot develop standards for manufactured housing, since federal (HUD) standards for manufactured housing pre-empt state standards. HCD can adopt State standards for factory-built housing, recreational vehicles, and commercial coaches; these units may pose indoor air quality concerns because of their low ventilation rates and the large quantities of synthetic building materials used in their construction.

HCD is required to adopt into the State Housing Law the portions of the latest model codes which relate to dwellings, apartment buildings, and hotels (HSC Section 17922). These model codes -- the Uniform Building, Mechanical, Housing, and Plumbing Codes and the National Electrical Code -- are published triennially by professional building organizations and must be put into effect by HCD within one year after their date of publication. HCD can amend the model codes prior to adoption to comply with State law or to protect the public health, safety, and welfare (HSC 17921 and 17922). The model codes are based on safety concerns such as fire, electrical, and explosion hazards rather than on health concerns or avoidance of indoor pollution hazards (McNamee, 1988). HCD does not have clear authority or sufficient scientific expertise to assess the effectiveness of the model codes in protecting indoor air quality; instead, HCD currently relies on other State agencies to make any necessary recommendations concerning indoor air quality (Pitts, 1988).

HCD is responsible for administering 23 different housing assistance programs (Deukmejian, 1988) which provide financial and technical assistance to local governments, non-profit agencies, and for-profit corporations. Currently, indoor air quality is not specifically addressed through housing assistance programs unless mandated by federal programs. For example, HCD programs that are funded by HUD must comply with federal

standards for the use or mitigation of lead paint and asbestos-containing materials (see HUD, Appendix F).

An indoor formaldehyde standard for manufactured homes and mobilehomes was recommended to HCD by DHS in July, 1984, pursuant to AB 2376, Deddeh (HSC Sec. 18616). Due to the standard's potential impact on housing costs, DHS also recommended additional study before taking any action. Consequently, HCD formed a task force which recommended State legislation in 1985 that would have required new manufactured homes and mobilehomes to provide the following: 1) compliance with standards for wood products which limit formaldehyde emissions; 2) an air exchange system; and 3) a health warning notice for consumers (Pitts, 1988). However, nearly identical requirements were soon proposed and eventually adopted as federal standards by HUD, which pre-empted any State or local government action. HCD has a Mobilehome Ombudsman position to handle public complaints about mobilehomes, including IAQ complaints (McGowan, 1988).

7. Department of Food and Agriculture (CDFA)

The California Department of Food and Agriculture (CDFA) carries out a comprehensive program for the regulation of pesticides. CDFA does not have any specific authority to regulate indoor air quality; however, through its general authority to regulate pesticides in California, CDFA actions can affect the levels and types of pesticides found indoors. CDFA registers pesticides; enforces laws regarding pesticide use, sale and transportation; licenses or certifies pesticide dealers, pest control advisors, pest control aircraft pilots, and agricultural pesticide applicators; investigates reported pesticide-related poisoning incidents through local County Agricultural Commissioners; and conducts research projects. After registration of a product, CDFA has the authority to evaluate potential health effects risks of both proper and improper application, and to require any additional data necessary to complete the evaluation. CDFA may restrict, cancel, or suspend the use of a product to mitigate possible adverse effects. CDFA has pre-eminent jurisdiction over pesticides and the registration process.

CDFA activities which are most directly related to IAQ include development of indoor exposure assessment protocols and the implementation of EPA's Inerts Policy and the 1984 California Birth Defects Prevention Act (FAC Sections 13121-13130). CDFA, in conjunction with other governmental and private agencies, has recently developed indoor exposure assessment protocols for use by registrants in meeting indoor exposure data requirements. Manufacturers who want to register indoor-use pesticides in California must supply CDFA with indoor exposure data, but heretofore have not had well defined indoor testing protocols to guide them. The protocols are currently being tested and validated.

Inert ingredients (those other than the active ingredients) in pesticide products may also present a problem. CDFA's adoption and implementation of EPA's Inerts Policy may also affect indoor and personal exposures to some pollutants. The policy requires that 116 toxic "inerts" (56 from List 1 and 60 on List 2 -- see Appendix S), including such substances as benzene, lead, carbon tetrachloride and asbestos, be phased out of pesticide products or that such products be re-labelled with an additional warning. Inert ingredients in pesticide products generally constitute the largest portion of the pesticide formulation, but are not normally listed on the label. Although manufacturers' compliance with the original phase-out deadline was poor, future compliance is anticipated (Jones, 1989).

CDFA's implementation of the Birth Defects Prevention Act of 1984 can also have an effect on indoor air quality since the Act requires that all chronic health data be reviewed to determine if each pesticide has a complete data base, and to determine if those data indicate any potential chronic health effects. If the information available shows a statistically significant or biologically important health effect, the pesticide will be placed into the risk assessment process to re-examine its potential risk to humans and to determine whether mitigation measures or registration restrictions should be imposed.

CDFA activities which may indirectly affect indoor air quality include implementation of the Toxic Air Contaminants Program and of

Proposition 65. CDFA also is currently conducting three research projects related to indoor air quality including pesticide exposure in greenhouses, pesticide spray technology, and infiltration into tractor cabs. These activities are discussed further in Appendix S.

8. Other State Agencies

A number of other State agencies can affect indoor air quality to a limited extent. Within the Department of General Services (DGS, Appendix T), for example, the Office of the State Architect (OSA) is involved in the design and construction of HVAC systems in State-owned buildings, and in 1984 initiated "bake out" procedures to reduce the concentrations of volatile air pollutants in new State offices. However, the "bake-out" procedures are only advisory and there is no specific requirement that they be followed. OSA also recently completed an asbestos survey of 11,000 State-owned buildings built prior to 1979, and has initiated or scheduled abatement work in 260 buildings which OSA believes require immediate attention and has requested funds for work in 680 buildings with a potentially serious problem (McClellan, 1989).

The State Building Standards Commission (SBSC) reviews and publishes proposed building standards and related administrative regulations which have been developed by HCD, CEC, and twelve other State agencies. SBSC reviews the procedures followed and documentation provided from other agencies' rulemaking activities, and assures that proposed standards neither conflict with nor duplicate existing building standards. SBSC has no authority directly related to indoor air quality, and, with minor exceptions, does not develop building standards of its own (see Appendix U). However, because so many agencies have authority over various aspects of building and ventilation standards, the role of SBSC is important in assuring that standards which are approved do not conflict with other existing standards and have been developed with adequate opportunity for input by the public and other interested agencies, including those with indoor air quality concerns.

The implementation of Proposition 65, the Safe Drinking Water and Toxic Enforcement Act of 1986, has limited applicability to indoor air quality, but its implications relative to indoor air exposures to toxics may be significant. The Act, which is being implemented by the Health and Welfare Agency with major assistance from DHS, required the Governor to publish a list of chemicals known to the State to cause cancer or reproductive toxicity. In addition to other requirements, the Act requires clear and reasonable warnings to be given before any individual is knowingly or intentionally exposed to a listed chemical. This warning requirement applies to indoor air exposures and exposures through other media, in addition to drinking water exposures. Although the Act does not prohibit discharge of toxics into indoor air, the warning requirements regarding known indoor air exposures may reduce people's air exposures to toxics through resultant avoidance behavior. Some specific indoor air pollutants, e.g., formaldehyde and asbestos, have already been listed and warning requirements have been imposed (see Appendix R).

Other state agencies also take actions which may affect indoor air quality. The California Public Utilities Commission (CPUC) regulates intrastate rates and services of investor-owned (but not publicly-owned) utilities as well as safety aspects of vehicles and vessels (such as buses and trains) which transport passengers or freight. The CPUC has required utilities to fund energy conservation programs which can affect indoor air quality but has taken no actions that specifically address indoor air quality issues. The Office of the State Fire Marshall, the Office of Statewide Health Planning and Facilities, and a number of other state agencies promulgate building standards which can directly affect indoor air quality. The actions of these agencies and a number of other agencies not discussed in this report can significantly affect air quality in certain indoor environments, but they are not discussed further in this report due to resource limitations.

C. LOCAL AGENCIES AND PRIVATE GROUPS

Local governmental units have taken significant actions to reduce exposure to environmental tobacco smoke through passage of many city and

county ordinances which restrict cigarette smoking (ANR, 1987). However, local government has neither adequate resources, nor in most cases, adequate expertise, to address the breadth of complex IAQ problems and issues that face the State today. Although local government may be the best body to implement specific IAQ mitigation measures, State-level guidance and technical and financial assistance appear to be necessary. The authorities and activities of local government related to indoor air quality and activities of private groups are summarized here and discussed in detail in Appendices V, W and X.

1. Air Pollution Control Districts (APCDs)

Local air pollution control districts (APCDs), have the primary responsibility to adopt regulations regarding stationary (non-vehicular) sources of air pollutants in order to assure attainment of both the federal and State ambient (outdoor) air quality standards. APCDs have broad authority over all types of non-vehicular air pollutant emissions, including those which constitute a public nuisance. However, the APCDs do not have authority to control indoor sources of pollutants for the purpose of reducing indoor exposures. Like the ARB, they may control indoor sources only for the purpose of reducing emissions to the outdoors where such controls are necessary to help meet the ambient standards or reduce outdoor concentrations of toxic air contaminants. Nonetheless, a few of the regulations promulgated for the purpose of reducing emissions to the outside atmosphere have also indirectly improved IAQ. Examples include restrictions on architectural coatings, various regulations related to asbestos emissions, and regulations regarding wood stoves and gas heaters in some areas of California.

A few of the larger districts have begun to consider issues specifically related to IAQ through studies and staff reports. The Bay Area Air Quality Management District (BAAQMD) presented to its board, in November 1985, an issue paper which briefly discussed and outlined issues and concerns with respect to indoor air pollution. The BAAQMD also recently initiated radon monitoring in 100 homes in the District. The South Coast Air Quality Management District has assessed the relative

contribution of in-vehicle exposure to individuals' total exposures to airborne toxics. A number of APCDs have also been called upon to assist in dealing with indoor air problems from organic chemicals, asbestos, and other pollutants in schools, homes, and public buildings.

2. City and County Governments

City and county governing bodies and administrative agencies can significantly affect indoor air quality through actions such as adoption of smoking ordinances, adoption and enforcement of local building codes, and health officer response to citizen requests for assistance with IAQ problems.

Many California cities and counties have enacted restrictive smoking ordinances to protect citizens from involuntary exposures to tobacco smoke. Among California cities and counties, as of June, 1987 (ANR, 1987):

- o 120 had a significant nonsmoker protection law;
- o 112 regulate smoking in private workplaces;
- o 113 require nonsmoking sections in restaurants; and
- o 99 restrict smoking in retail stores.

In addition, since June, 1987, thirty more California cities and counties have enacted ordinances to control smoking in public places or work places. Through these regulations, over 50 percent of Californians now reside in a community where smoking is restricted in private workplaces and/or specified public buildings such as restaurants (ANR, 1987; ANR, 1988).

Local governments--usually local building departments--enforce State housing and building regulations through the checking of house plans, inspection of construction, and corrections of standard violations. Local governments may also adopt amendments to State building regulations that are no less stringent than the State regulations; the amendments usually must be based on special needs due to local climate, topography, or

geology. Local governments must report such amendments to HCD, CEC, or the appropriate State agency and make their findings publicly available (see Appendix Q). Thus, it would appear that local governments could adopt more stringent requirements, for example, to control entry of radon into buildings, at least in areas of high soil radon content. Local governments may also approve the use of new or alternative building materials or methods, including those which could affect indoor pollutant emissions or ventilation. To approve the use of materials or methods not mentioned in model codes or State standards, the local building department must find that the materials or methods are equivalent to the State building standards in performance and protection of health, safety, and welfare.

Local health departments and environmental health departments also have broad responsibilities to provide basic health-related services to the jurisdictions they serve, including air sanitation services (HSC Sec. 1276[e][10]). They must also provide counseling and educational services related to health (HSC Sec. 1276[i]) and services in occupational health to promote the health of employed persons and a healthful work environment (HSC Sec. 1276[j]). Local health and environmental health departments generally do not have explicit authority to regulate indoor air quality, although exercise of their general authority as it relates to air quality in enclosed environments may include authority to address indoor exposures to air pollutants.

Local health departments have received increasing numbers of indoor air quality complaints in recent years (OHSEP, 1987). Health officials generally respond by providing information, conducting site visits, or referring the individual to other agencies such as DHS or the local APCDs. However, the ability of the local health departments to adequately respond is limited by lack of staff resources, fiscal support, clear lines of responsibilities, specific staff training, and definitive guidelines or standards (Quinton, 1986; OHSEP, 1987). DHS has previously worked with and is currently working with local health departments and their

representative groups to provide additional information and training regarding indoor air quality problems and corrective/preventive measures (Quinton, 1986; Hayward, 1989).

3. Standards Organizations/Private Groups

Several private sector organizations develop recommendations which serve as "consensus standards" for indoor air quality assessment and mitigation. Some of these standards are incorporated into the regulations of government agencies. Concern has sometimes been expressed regarding the validity and effectiveness of such standards in protecting public health and welfare. However, although they may not meet all recognized needs, consensus standards serve an important function by providing guidelines for professionals such as building designers, managers and consultants, often long before government rule-making procedures could provide similar guidance. In fact, government agency staff often actively participate in the development of such consensus standards by serving on standards-development committees of the major standards organizations.

The American Society for Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE, Appendix X) has adopted a number of standards related to IAQ, including those for ventilation and IAQ (Standard 62), air filter performance, thermal comfort, and air-to-air heat exchanger performance. These ASHRAE standards, especially Standard 62, have provided part of the basis for some building standards adopted by agencies such as HUD, HCD, CEC, and local governments. Thus, ASHRAE standards have played a significant role in the current regulation of ventilation system design and energy-efficient building design as they relate to indoor air quality.

ASHRAE's Standard 62, first adopted in 1973, was initially based on criteria of odor perception and carbon dioxide concentrations, with a prerequisite that all outdoor and re-circulated air meet State or federal outdoor air quality standards. The Standard included minimum ventilation rates and specified higher recommended ventilation rates for areas with smoking or other indoor sources of pollutants present. In 1981, ASHRAE

revised Standard 62-1973 to resolve discrepancies with energy conservation standards and to incorporate new IAQ information. The revised standard, ASHRAE Standard 62-1981, permitted lower ventilation rates in nonsmoking areas and included additional air quality guidelines for several non-criteria pollutants such as formaldehyde and radon.

However, controversy arose soon after adoption of the new Standard (see Appendix X). Consequently, for the past few years ASHRAE Standard 62-1981 has been undergoing revision. It is clear that proposed revisions to the Standard are controversial and that the new Standard may be more or less protective of indoor air quality depending on the final outcome. The EPA has been particularly diligent in commenting on proposed revisions. Final adoption of a revised Standard could occur in mid-1989.

The American Conference of Governmental Industrial Hygienists (ACGIH) develops Threshold Limit Values (TLVs) as recommended levels for workplace air quality based on 8 hours per day or 40 hours per week exposure. The ACGIH also develops short-term exposure limits and ceiling limits. TLVs are based on experimental human and animal studies and information from industrial experience, and are intended to protect most workers from both material impairment and irritant effects. The ACGIH notes, however, that more susceptible individuals may experience adverse effects at or below its standard limits, that its limits are not fine lines between safe and dangerous conditions, and that its limits are not intended for evaluation or control of community air pollution nuisances or other uses but are strictly designed for guidance in industrial workplaces (ACGIH, 1985). OSHA and Cal-OSHA have relied extensively on ACGIH TLVs and other exposure limits in setting occupational health and safety standards.

Another organization, the American Society for Testing and Materials (ASTM) is becoming increasingly involved in developing standards related to IAQ. ASTM standards generally consist of methods or protocols for sampling or measuring air concentrations of specific pollutants. Many more sampling protocols related to IAQ are currently being developed. Recently, an ASTM labeling standard for hazardous art materials (ASTM

Standard D-4236) was adopted as a federal standard which pre-empted several existing state standards (PL 100-695, Art Supplies Labeling Act).

Other private groups such as the Gas Research Institute, the Electric Power Research Institute, and the American Lung Association have conducted significant research and/or public awareness efforts related to the assessment and mitigation of IAQ. Also, a number of institutions and other countries such as the World Health Organization, Canada, Japan, and several European countries have developed health- and comfort-based guidelines for indoor air quality. It is clear that future government actions to address specific aspects of IAQ should fully consider prior activities of such groups to avoid duplication of effort and to benefit from the extensive IAQ experience of those organizations.

D. SUMMARY MATRICES OF FEDERAL, STATE, AND LOCAL GOVERNMENT IAQ AUTHORITIES

The following matrices provide summary information regarding authority of various levels of government over indoor sources of pollutants (Matrices I and II); building and ventilation system design, construction, operation, and maintenance (Matrices III and IV); and type of enclosed space (Matrices V and VI). An entry for an agency in a specific category simply means that the agency has some degree of authority--direct or indirect, full or limited--for that activity as indicated. In most cases the authority has been utilized to some degree, but in some cases the authority has not been exercised at all.

The matrices are intended as an aid in identifying the primary government agencies which are or could be involved in various aspects of IAQ, but are not meant to be all-inclusive. Some agencies which have a limited role (for example, the General Services Administration which manages many federal buildings throughout the country) have not been included. Also, it should be noted that the inclusion of many agencies within a matrix cell does not necessarily mean that that aspect of IAQ is

being fully or adequately addressed. Similarly, empty cells or near-empty cells do not necessarily imply that specific authority over that aspect of IAQ is desirable. For example, no agencies have regulatory authority over residential air quality per se, but we do not recommend assigning such authority to a single agency. Rather, source controls, public education, and ventilation and building standards should be used to assure healthful residential air quality, as discussed in the next chapter.

MATRIX I

FEDERAL AGENCY IAQ AUTHORITY — INDOOR POLLUTANT SOURCES

Source Authority	Cigarettes	Building Materials & Furnishings	Combustion Appliances	Pesticides	Cosmetics, Drugs, Med. Devices	Other Consumer Products	Water and Soil
Research & Assessment	DHHS (1) EPA (2)	CPSC (2) HUD (2) DOE (2) NASA (2)	CPSC (1) DOE (2) HUD (2)	EPA (1) HUD (2)	FDA (1)	CPSC (1) EPA (2)	EPA (1) DHHS (1) HUD (2)
Public Education	DHHS (1) EPA (2)	CPSC (1) HUD (2) DOE (2)	CPSC (1) DOE (2) HUD (2)	EPA (1) HUD (2)	FDA (1)	CPSC (1) EPA (2)	EPA (1) DHHS (1) HUD (2)
Regulatory Authority		CPSC (2) HUD (2) DOE (2)	CPSC (1) DOE (2) HUD (2)	EPA (1) HUD (2)	FDA (1)	CPSC (1)	EPA (1&2) HUD (2)
Compliance Authority		CPSC (2) HUD (2) DOE (2)	CPSC (1) DOE (2) HUD (2)	EPA (2) HUD (2)	FDA (1)	CPSC (1)	EPA (1&2) HUD (2)

(1) Direct or complete authority
(2) Limited or indirect authority

MATRIX II

STATE AND LOCAL* AGENCY IAQ AUTHORITY — INDOOR POLLUTANT SOURCES

Source Authority	Cigarettes	Building Materials & Furnishings	Combustion Appliances	Pesticides	Cosmetics, Drugs, Med. Devices	Other Consumer Products	Water and Soil
Research & Assessment	DHS (1) ARB (2)	DHS (1) DCA (2) CEC (2) HCD (2)	DHS (1) CEC (2) DCA (2) HCD (2)	DHS (1) CDFA (1) SPCB (2)	DHS (1) DCA/BOC (2)	DHS (1) DCA (2)	DHS (1) CEC (2) HCD (2)
	DHS (1)	DHS (2) DCA/BHFTI (2) CEC (2) HCD (2) LOCAL (2)	CEC (2) DCA (2) HCD (2) DHS (1)	CDFA (1) SPCB (2)	DCA/BOC (2) DHS (2)	DCA (2) LOCAL (2) DHS (2)	DHS (1) CEC (2) HCD (2) LOCAL (2)
Regulatory Authority	LOCAL (1)	DHS (2) DCA/BHFTI (2) CEC (2) HCD (2) LOCAL (2)	CEC (2) HCD (2) LOCAL (2) DHS (2)	CDFA (1) SPCB (2)	DCA/BOC (2) DHS (2) ARB (2)	DHS (2) ARB (2) DCA (2) LOCAL (2)	DHS (1) CEC (2) HCD (2) LOCAL (1)
Compliance Authority	LOCAL (1)	DCA/BHFTI (2) CEC (2) LOCAL (2)	CEC (2) HCD (2) LOCAL (2) DHS (2)	CDFA (1) SPCB (2) LOCAL (2)	DCA/BOC (2) DHS (2) ARB (2)	DHS (2) ARB (2) DCA (2) LOCAL (2)	DHS (2) LOCAL (1) CEC (2) HCD (2)

(1) Direct or complete authority
(2) Limited or indirect authority

* "Local" may include city and county governing bodies; city and county agencies such as health departments; air pollution control districts; and County Agricultural Commissioners.

MATRIX III

FEDERAL AGENCY IAQ AUTHORITY — BUILDING AND VENTILATION SYSTEMS

Control Authority	RESIDENTIAL		NON-RESIDENTIAL	
	Building and Ventilation Design & Construction	Building and Ventilation Operation & Maintenance	Building and Ventilation Design & Construction	Building and Ventilation Operation & Maintenance
Research & Assessment	HUD (1) DOE/BPA (1)	HUD (2) BPA (2-N.W. U.S. only)	HUD (1) DOE/BPA (1)	DHHS/NIOSH (1)
Public Education	HUD (1) DOE/BPA (1)	HUD (2) BPA (2-N.W. U.S. only)	HUD (1) DOE/BPA (1)	DHHS/NIOSH (1)
Regulatory Authority	HUD (2) BPA (2-N.W. U.S. only)	HUD (2) BPA (2-N.W. U.S. only)	HUD (2) BPA (2-N.W. U.S. only) OSHA (2)	OSHA (2)
Compliance Authority	HUD (2) BPA (2-N.W. U.S. only)	HUD (2) BPA (2-N.W. U.S. only)	HUD (2) BPA (2-N.W. U.S. only) OSHA (2)	OSHA (2)

(1) Direct or complete authority

(2) Limited or indirect authority

MATRIX IV

STATE AND LOCAL* AGENCY IAQ AUTHORITY — BUILDING AND VENTILATION SYSTEMS

Control Authority	RESIDENTIAL		NON-RESIDENTIAL	
	Building and Ventilation Design & Construction	Building and Ventilation Operation & Maintenance	Building and Ventilation Design & Construction	Building and Ventilation Operation & Maintenance
Research & Assessment	DHS (1) CEC (1) HCD (2)	DHS (1) CEC (2) HCD (2)	DHS (1) CEC (1) HCD (2) Cal-OSHA (2)	DHS (1) CAL-OSHA (2) CEC (2)
Public Education	CEC (2) HCD (2) LOCAL (2)	HCD (2) DHS (2)	CEC (2) HCD (2) Cal-OSHA (2) LOCAL (2)	CAL-OSHA (2) DHS (2)
Regulatory Authority	CEC (2) HCD (2) LOCAL (1) Other state (2)	HCD (2)	CEC (2) HCD (2) Cal-OSHA (2) Other state (2) LOCAL (1)	CAL-OSHA (1) LOCAL (2) Other State (2)
Compliance Authority	CEC (2) HCD (2) Other state (2) LOCAL (1)	HCD (2)	CEC (2) HCD (2) Other state (2) LOCAL (1)	CAL-OSHA (2) LOCAL (2) Other state (2)

(1) Direct or complete authority
(2) Limited or indirect authority

* "Local" may include city and county governing bodies; city and county agencies such as health departments; air pollution control districts; and County Agricultural Commissioners.

MATRIX V

FEDERAL AGENCY IAQ AUTHORITY -- TYPE OF ENCLOSED SPACE

Enclosed Space Authority	Residences	Workplaces	Public Buildings	Transportation Conveyances
Research & Assessment	DOE/BPA (2) DOD (2) EPA (2) HUD (2)	OSHA (1) DHHS/NIOSH (1) DOD (2)	DOE/BPA (2) EPA (2)	DOT/FAA (1)
Public Education	DOE/BPA (2) EPA (2) HUD (2)	OSHA (1) DHHS/NIOSH (1)	EPA (2)	DOT/FAA (2)
Regulatory Authority	DOE/BPA (2) DOD (2) HUD (2)	OSHA (1) DOD (2)	OSHA (2)	DOT/FAA (2)
Compliance Authority	HUD (2)	OSHA (1) DOD (2)	OSHA (2)	DOT/FAA (2)

(1) Direct or complete authority
(2) Limited or indirect authority

MATRIX VI

STATE AND LOCAL* AGENCY IAQ AUTHORITY -- TYPE OF ENCLOSED SPACE

Enclosed Space Authority	Residences	Workplaces	Public Buildings	Transportation Conveyances
Research & Assessment	DHS (1) ARB (2) CEC (2) HCD (2)	CAL-OSHA (2) DHS (2)	DHS (1) ARB (2) CEC (2) HCD (2)	DHS (1) ARB (2)
Public Education	DHS (2) ARB (2) CEC (2) HUD (2)	CAL-OSHA (1) DHS (2)	DHS (2) ARB (2) CEC (2) HCD (2)	DHS (2) ARB (2) CPUC (2)
Regulatory Authority		CAL-OSHA (1)	CAL-OSHA (2) LOCAL (2)	CAL-OSHA (2) CPUC (2)
Compliance Authority		CAL-OSHA (1)	CAL-OSHA (2) LOCAL (2)	CAL-OSHA (2) CPUC (2)

(1) Direct or complete authority
(2) Limited or indirect authority

* "Local" may include city and county governing bodies; city and county agencies such as health departments; air pollution control districts; and County Agricultural Commissioners.

IV. MITIGATION NEEDS AND RECOMMENDED ACTIONS TO ADDRESS THEM

A. GENERAL NEEDS AND RECOMMENDATIONS

1. Need for a Comprehensive State Approach

There is clearly a need to protect and enhance IAQ, but it is evident that only limited effective actions to do so have been taken thus far. This is largely because no State or federal agency has a direct mandate or full authority to develop regulations to protect IAQ. Rather, many agencies have indirect authority over one or several aspects of IAQ. Lead agencies for research and coordination have been designated at both the federal (EPA) and State (DHS) levels. Both EPA and DHS have focused on research and public education, which are critical elements in identifying and addressing indoor air pollution problems. However, no federal or State agency has taken actions which comprehensively or adequately reduce Californians' exposures to indoor air pollutants.

At the federal level, the EPA is addressing exposures to asbestos and radon through programs mandated by Congress under various acts. Also, EPA has developed or is developing memoranda of understanding with a few other federal agencies (DOE, HUD) regarding lines of jurisdiction related to indoor air quality. However, EPA's approach is primarily non-regulatory, and, as mentioned earlier, the EPA will provide technical assistance but will leave actual mitigation of indoor problems largely to state and local governments. Moreover, actions taken by EPA and other federal agencies are often slow and are not always appropriate for California's specific needs.

Within California, no comprehensive State plan to address indoor air quality has been developed and few specific actions have been taken which will actually reduce exposures to indoor pollutants. DHS has not initiated memoranda of understanding with other State agencies whose actions affect IAQ. Only two specific mitigation measures--the Cal-OSHA Minimum Building Ventilation Standard (see Appendix N) and CEC's urea-formaldehyde foam insulation regulations (see Appendix O)--have been taken

by State agencies. The IWG has focused largely on coordination of research and public education activities.

Recommendation 1: A comprehensive State plan which assures reduction of indoor air pollutant exposures in California and which includes memoranda of understanding among appropriate State agencies should be developed. The plan should be implemented through existing authority over IAQ to the extent feasible. The plan should include explicit goals, objectives, target dates, and periodic progress reviews.

2. Need for IAQ Health-based Guidelines

Currently, there are no comprehensive national or State guidelines available that adequately indicate to building managers, members of the public, and health practitioners how healthful IAQ might be defined in non-occupational indoor environments. When an IAQ problem arises, it is often not clear how extensive mitigation should be to restore a healthful public or residential indoor environment, nor is it clear how to determine whether a healthful environment has been achieved once mitigation measures have been implemented. Therefore, indoor air quality health-based targets or goals should be developed.

Other countries, a few states, and various industry groups have developed sets of IAQ guidelines for various purposes. Of these, the health-based guidelines recently developed by Canada (Canada, 1987) are perhaps most instructive and relevant for meeting California's needs. Similarly, ASHRAE has for many years provided standards for ventilation and IAQ (ASHRAE Standard 62-1981, currently under revision) which are often incorporated in whole or in part into state and local building standards. These and other established guidelines would serve as useful models in the development of California guidelines. However, these guidelines are limited in scope and do not explicitly address all aspects of IAQ in California for which guidance is needed. Guidelines which specifically and fully address California non-industrial indoor environments are needed.

In addition to using portions of IAQ guidelines developed by other groups, California guidelines should also rely heavily on the extensive body of knowledge regarding the health effects of various pollutants compiled and assessed for the ARB's Ambient Air Quality Standards Program

and Toxic Air Contaminants Program. California's health-based ambient air quality standards for criteria pollutants define healthful air quality. They are based on identification of the lowest short-term exposures that result in an adverse health effect, and incorporate a margin of safety. California's ambient standards for criteria pollutants, then, could be used as initial guidelines for criteria pollutants in indoor environments. For example, the eight-hour standard for carbon monoxide is 9 ppm. Carbon monoxide concentrations averaging less than 9 ppm over an eight-hour period are equally safe whether breathed indoors or outdoors. Thus, the ambient standard for carbon monoxide would be appropriate as a guideline for indoor air quality as well.

The development of IAQ guidelines for non-threshold pollutants, such as many of the carcinogens addressed under the Board's Toxic Air Contaminants Program, is more problematic, since any exposure to such pollutants may contribute to an adverse health effect. The Board's approach of reducing outdoor emissions of such substances to the lowest level achievable through application of the best available control technology is again instructive in developing IAQ guidelines for those substances. In IAQ guidelines, non-threshold pollutants and their major indoor sources should be identified, along with recommended control measures which might be used to reduce those emissions. This is somewhat similar to Canada's approach where, for pollutants for which no safe level of exposure can readily be identified, general guidelines are offered for reducing indoor exposures to those substances to minimize risk.

Recommendation 2: As sufficient data become available, the ARB staff should develop health-based indoor air quality guidelines for non-occupational indoor environments for consideration by the Board. These guidelines should identify safe exposure levels for Californians where such levels can be identified, and provide guidance in reducing indoor exposures to pollutants for which safe levels cannot be identified.

3. Need for Capability and Resources to Adequately Respond to
Citizen Requests for Assistance in Solving Residential IAQ
Problems

Currently there are no State or local agencies with clear authority and adequate resources to respond to citizens' requests for assistance in

solving residential IAQ problems. The number of such requests to State and local agencies has increased significantly in recent years (Macher, 1988; Jenkins, 1988). However, no agency has a direct mandate to conduct residential inspections, and those agencies whose general authority permits them to do so (primarily the State and local health agencies) do not have sufficient staff, equipment, or funding (and in the case of local agencies, sufficient training) to adequately respond to the vast majority of requests received.

Most citizens who seek help with indoor air quality problems are provided information over the telephone by one or more government agencies or private groups (such as DHS or the American Lung Association) but must turn to private air testing firms if their problem is not readily resolved through telephone advice. Unfortunately, most firms that provide air testing services are exceedingly expensive for the average citizen (inspection costs often start at about \$1000 and increase rapidly). Also, the air quality tests frequently fail to identify an offending air pollutant, either because testing was delayed after a problem became evident, was not done for the proper pollutant, testing was conducted incorrectly or inappropriate equipment was used, or no single pollutant is a major offender. In addition, because indoor air quality testing and problem definition is a relatively new field, the level of expertise and training varies significantly among companies that provide indoor air testing and assessment services. Because there are no certification or registration requirements for such companies, citizens have no way of judging whether companies which advertise indoor air testing services are in fact knowledgeable about the field and are familiar with all aspects of indoor air quality assessment that may be pertinent to their particular problem.

For several reasons, local health departments and/or air pollution control districts (APCDs) are the logical agencies of choice to assist homeowners in identifying and mitigating their IAQ problems. First, they are physically closest to local residences (as opposed to most State and federal agencies) and are the government units to which citizens have traditionally turned for assistance with other residential health and

safety problems or air quality concerns. Second, indoor air quality problem assessment appears to fall within the general authority of local health departments (see Appendix W), and could logically fall as well under APCD authority in the future should authority be given to either EPA or ARB to regulate indoor sources of pollutants (see next section).

While local government units appear to be best suited for initial residential problem identification, they currently lack the training and especially the resources to be able to render the necessary assistance. Neither local health department staff nor APCD staff are specifically trained in IAQ monitoring and assessment, although some health department personnel are trained in industrial hygiene assessment techniques. IAQ inspectors need training about the many causes of indoor pollution, ventilation system design and operation, insulation, gas appliances, indoor air testing (when and how it should be done) and so on. They must also have available proper indoor air monitors. Equally important, resources must be available for maintenance and repair of the monitors once they are purchased and in use.

Recommendation 3: Local health and environmental health departments and/or APCDs should be provided with the staff, training, equipment, and fiscal resources to conduct initial residential inspections when necessary in response to citizen requests for assistance in identifying and resolving residential indoor air quality problems. Where necessary, a clear mandate and a specific funding mechanism should be provided for this function.

Recommendation 4: Private companies offering residential inspection, testing, and mitigation services for indoor air quality problems in California should be required to complete a State certification process. The State certification process should require at a minimum: completion of a State-offered or State-approved indoor air quality inspection and mitigation training course; written and field tests; and re-certification every three to five years.

B. NEEDS AND RECOMMENDATIONS RELATED TO SOURCE CONTROLS

Although many federal agencies and a few State agencies have some degree of authority over one or more indoor sources of pollutants, none has comprehensive authority, and most do not have authority to specifically address indoor air pollutant emissions. Consequently, only a

few indoor pollutant sources are regulated for the purpose of reducing indoor emissions, and emissions from some other indoor sources have been reduced indirectly through regulations developed for other purposes. There is a need, particularly at the State level, for authority to regulate indoor sources of pollutants for the purpose of reducing indoor exposures.

1. Need for State Authority to Control Indoor Emissions from Consumer Products

General Consumer Products and Combustion Appliances

As discussed earlier, the federal CPSC has the primary regulatory authority over most types of consumer products. Like other federal regulatory agencies, the CPSC has had significant delays in the regulatory process due to lengthy federal rule-making requirements and frequent lawsuits. In recent years, the CPSC has turned from mandatory standards to voluntary standards; however, voluntary standards may not sufficiently reduce the risk posed by indoor exposures to various consumer products.

Also, CPSC at times takes regulatory actions which are inadequate to protect public health. For example, CPSC has recently taken an action which is clearly inadequate to protect consumers from significant indoor exposures to methylene chloride. Although CPSC staff estimated that exposures to methylene chloride during use of paint strippers alone would produce lifetime cancer risks of 110-4400 per million (51 FR 29778-29809), the CPSC, rather than adopting a more stringent measure (such as banning household products containing methylene chloride as requested by the Consumer Federation of America in a petition), issued a "Statement of Enforcement Policy." That policy states that methylene chloride is considered to be a hazardous substance and that products containing methylene chloride are therefore required to be properly labelled (CPSC, 1987). However, labeling does not assure reduction of exposure due to the inability of some consumers to read, understand, and properly act upon the information provided on a label, and because some individuals simply neglect to do so. In California in particular there is an increasing

proportion of residents who are non-native and whose English skills may not yet be adequate to enable them to fully understand and appreciate the significance of a warning label (see discussion below). Consequently, the action taken by CPSC is inadequate to assure reduction of risk, and is clearly inadequate to reduce risk levels to less than one lifetime cancer case in a million, the criteria level for action which is increasingly being used either implicitly or explicitly by various regulatory agencies. The Consumer Federation of America has recently filed suit over CPSC's failure to ban methylene chloride in consumer products (Fise, 1988).

Through the Toxic Substances Control Act, the EPA has limited authority over substances in some consumer products. However, where such substances and products can be adequately regulated under other federal authorities, such as the CPSC, EPA generally must defer to that other authority. The EPA has also taken actions to regulate the use of certain substances under its other authorities, such as asbestos controls under the Clean Air Act, and such actions have had beneficial effects in terms of reducing indoor exposures. However, EPA has no direct authority to address indoor exposures from consumer products.

The types of products which can be regulated by the CPSC for health and safety purposes are generally not regulated for air quality purposes by any California agency. The mandate of the California Department of Consumer Affairs differs from that of the CPSC in that the DCA does not regulate consumer products directly, but rather regulates services provided to consumers and those who provide them, and addresses consumer complaints. The State Department of Health Services has limited authority over certain consumer products, but generally may not regulate beyond the federal requirements (HSC Sec. 28758.5). Although DCA and DHS may propose legislation to ban or restrict products which they believe warrant such action and which are not already regulated directly at the federal level, such an approach has not been used by either agency to directly address harmful indoor exposures to consumer products.

Combustion appliances are regulated at the State level by CEC for the purpose of increasing their energy efficiency. Although appliance

standards developed by CEC must assure public health and safety, the CEC does not appear to have authority to regulate appliance pollutant emissions for the sole purpose of improving indoor air quality. HCD has a general mandate to regulate appliance design, installation, and operation in residential buildings, but has relied on safety-based rather than health-based model codes developed by others. Given the absence of other explicit State or federal authority in this area (aside from CPSC's authority), it would appear that CEC and HCD could more actively address indoor air quality through appliance standards and building standards should they choose to do so.

Food, Drugs, Cosmetics, Cigarettes

The federal Food and Drug Administration (FDA) regulates food, drug and cosmetic products and medical devices to assure that they are not adulterated or misbranded. However, indoor exposures to harmful substances in cosmetic products, such as methylene chloride in hair sprays, formaldehyde in shampoos, and acrylics in nail products, have resulted in adverse health effects and have been the topic of recent congressional hearings (see Appendix G). The FDA can ban a substance in, or require specific labeling of, a cosmetic product if it is aware of a harmful component substance. However, the agency leaves the determination of the safety of cosmetic products to the manufacturers. Specific toxicological tests are not required, and there are no legal ramifications if manufacturers do not conduct desirable toxicological tests prior to marketing a cosmetic product (Decker, 1988; FDA, 1986).

The FDA is currently under pressure from the Surgeon General to regulate cigarettes (particularly the new smokeless cigarettes) as a drug, since they could be classified as a drug (nicotine) delivery device. Cigarettes are currently regulated at the federal level by the Bureau of Alcohol, Tobacco and Firearms and the Federal Trade Commission for purposes of taxation, trade, and advertising only; no federal agency regulates the health risk posed by tobacco products. Indoor exposure to cigarette smoke in California has been partially regulated at the local level under city and county ordinances (ANR, 1987); in public

transportation vehicles and stations and specified public places by the California Legislature (HSC Sec. 25940 et seq.); and in airliner cabins by Congress (PL100-202). As mentioned earlier, about 50 percent of California citizens live in communities without local ordinances to prevent involuntary exposure to environmental tobacco smoke in public buildings (ANR, 1987; ANR, 1988).

2. Need for State Authority to Regulate Emissions from Building Materials and Furnishings

At the federal level, the CPSC, and to some extent HUD, have authority to regulate emissions from building materials, but progress has been slow. Emissions of total organics and many specific substances such as plastics and acrylics have not yet been addressed. Given the increasing health problems experienced in new and remodeled buildings, the increasing use of synthetic building materials, and the apparent increase in the percent of chemically sensitive individuals in the population, building material standards for the purpose of reducing indoor exposures to harmful and irritant substances appear necessary. At the State level, building materials generally are not regulated for the purpose of reducing indoor pollutant exposures. The one exception is insulation materials, which are regulated by CEC and DCA's Bureau of Home Furnishings and Thermal Insulation (BHFTI). However, State insulation material standards have focused thus far on formaldehyde emissions, odor emissions, and treatment for resistance to fungi; they do not currently address total organic emissions, fine particle emissions, or other potential IAQ problems.

Home and office furnishings can also emit significant amounts of potentially harmful or irritating particulate or organic substances, such as formaldehyde. In California, emissions from furnishings remain unregulated except for upholstered furniture and bedding materials, which are regulated by the BHFTI. However, BHFTI regulations only address labeling requirements and sterilization methods and substances, and BHFTI's authority does not extend over other furnishings such as carpets and draperies.

3. Need for Source Controls Due to Inadequacy of Product Labeling as a Risk Reduction Measure in California

A number of state and federal agencies which regulate household consumer products, building materials and furnishings, pesticides, and other products for various health and safety purposes rely heavily on product labeling as a measure to reduce the risk posed by use of the product. However, labeling alone appears inadequate to reduce risk in California because a significant portion of California's adult residents are functionally illiterate in English, i.e., they are not able to read and understand the directions on product labels. Studies conservatively estimate that at least 3.1 million Californians, or about 15 percent of the population aged 15 years or older, are functionally illiterate in either English or Spanish (NOMOS, 1979; Dixon et al., 1987; SOR, 1986).

Although English-speaking Caucasians make up the largest proportion (1.3 million or 43 percent) of the functionally illiterate adult population in California, influxes of non-English speaking immigrants and refugees have recently increased and may be exacerbating the problem (Dixon et al., 1987). From 1983 to 1988, California received about 1.25 million foreign immigrants (Allen and Turner, 1988; INS, 1987, 1988, 1989), in addition to 438,000 refugees as of late 1987 (DOF, 1988) and 1.36 million applicants for legalization as of early 1989 (INS, 1989). These figures translate to 30 percent of the national totals for immigrants and refugees and 54 percent of the national total for legalization applicants. However, California constitutes only 11 percent of the total U.S. population; consequently, California is receiving a disproportionately large share of U. S. immigrants, including many who do not read or speak English. Thus, labeling requirements for products may be particularly ineffective in reducing risk for California residents.

There is also evidence that literate persons frequently neglect to read or heed label warnings and instructions. Labels on household and commercial pesticides have not prevented over 50,000 adverse acute exposures each year to consumers as well as to "trained" commercial applicators in California alone (SOR, 1988; O'Malley, 1989; Edmiston,

1987; Krieger et al., 1989). A national usage survey of 32 different household solvent products found that an average of 30 percent of the respondents said that they had not read the label directions before last using the product (WESTAT, 1987). Other studies suggest that, where complicated directions and procedures (e.g., respirators, ventilation, and clean-up) are required to safely use a product, labeling and other types of consumer information are unlikely to achieve significant modifications of consumer behavior (Adler and Pittle, 1984; Staelin, 1978). Thus, labeling requirements are not fully effective risk reduction measures, even among literate individuals.

The prospects for significantly reducing consumer exposures to indoor air pollutants through product labeling, then, are not particularly promising. Labeling in foreign languages for non-natives would not help much because of high illiteracy rates of native-speakers in a foreign language (Solorzano, 1989; BCEL, 1989) and because of the large number of different languages spoken in California. Also, the sheer volume of advertising, which often contradicts the message in the warning labels, may overwhelm any impact of warning labels (USSG, 1989).

Consequently, although product label requirements do serve a functional purpose of informing and warning a portion of the population, additional risk reduction measures appear warranted in California. Source controls are generally the most effective risk reduction measures since they prevent or reduce the possibility of exposure regardless of the user's actions. Product source controls might include pollutant emission limitations, chemical ingredient reformulations, and product use restrictions. Such measures, in conjunction with more targeted public education efforts, economic incentives, and other approaches, appear necessary to effectively reduce the risk from indoor pollutant emissions from consumer products in California.

Recommendation 5: The Air Resources Board should be given responsibility to develop control measures to be used to mitigate indoor sources of non-occupational exposures to designated Toxic Air Contaminants and pollutants for which the Board has adopted State Ambient Air Quality Standards, where no such responsibility currently exists.

This recommendation is based on the need for a clear mandate for a single State agency to oversee and, as necessary, regulate indoor pollutant sources. The current multi-agency system includes unclear authorities at both State and federal levels, significant regulatory gaps at the State level, potential conflict with primary missions (e.g., energy conservation vs. indoor air quality improvement), and insufficient exercise of existing authorities. The EPA, through its Indoor Air Quality Implementation Plan, has made it clear that although the federal government will conduct research and provide technical assistance, the actual mitigation of indoor air quality problems will be left to state and local governments.

The ARB is the appropriate State agency to oversee and regulate indoor pollutant sources because its primary mission is to protect air quality, and it has both a clearly established regulatory process and extensive experience in addressing pollutant emissions from a variety of sources. The ARB has demonstrated the ability and willingness to establish goals and objectives and to carry out programs in a timely, effective manner, and has significant experience in the fields of exposure assessment and indoor air quality.

Most important, perhaps, is the ARB's ability to address indoor air pollutant exposures in the most direct, cost-efficient manner possible through the integration of indoor mitigation measures with existing Board programs. This avoids the need to create new risk management programs in other agencies. Currently the Board's Toxic Air Contaminants Program and State Ambient Air Quality Standards Program address only outdoor exposures to regulated pollutants. In reviewing the population's exposures to pollutants regulated through these programs, the Board has become aware that significant exposures to some of those pollutants occur indoors due to indoor sources. (For example, more than one-third of the pollutants considered under the Board's Toxic Air Contaminants Program are known to have indoor sources). When indoor exposures to a specific pollutant are determined by the Board to be inadequately addressed, a variety of mitigation measures could be implemented. These might include public education, development of economic incentives, product use restrictions,

emission limitations, and chemical ingredient reformulations. For a number of pollutants, it is likely that such measures would be significantly more cost-effective in reducing risk than imposition of certain additional outdoor source controls. Thus, cost-efficiencies could result both by addressing indoor exposures through existing ARB risk management processes and by reducing the need for certain outdoor control measures when more effective indoor mitigation measures can be implemented.

It should be noted that the ARB could significantly reduce indoor pollutant exposures through control of indoor sources despite the pre-emption provisions of some related federal statutes. The CPSC pre-emption provision, for example, does not apply to products or risks not yet addressed by CPSC consumer product standards and labeling requirements. Consequently, numerous consumer products could be controlled by State agency actions to reduce the risk posed by indoor inhalation exposures, since CPSC has specifically addressed only limited indoor products/risks thus far. Also, because the pre-emption provision does not appear to apply to products/risks addressed by voluntary standards (see Appendix C), and because the CPSC is largely focusing on voluntary standards, near-term CPSC actions would not be anticipated to significantly affect the ARB's ability to reduce indoor consumer product emissions.

C. NEEDS AND RECOMMENDATIONS RELATED TO BUILDING AND VENTILATION STANDARDS

1. Need for More Protective Building and Ventilation System Design and Construction Standards

A number of agencies at both the federal and State levels of government (DOE, HUD, CEC, HCD, and others) as well as city and county governments have some degree of authority to set building and ventilation system design and construction standards. Although none of these governmental units has the explicit mandate to develop standards to improve or protect indoor air quality, each has a general responsibility to assure public health and safety through their actions. Agencies such

as DOE and CEC have undertaken significant, but not consistent, efforts to assess the impacts of building standards on indoor air quality, primarily those targeted toward energy conservation.

In light of the increasing cases of sick (new) building syndrome being reported, the recent knowledge regarding risk posed by seepage of radon gas into some buildings (NRC, 1988), and known instances of lateral migration of toxic pollutants from waste disposal sites through soil into nearby buildings, it would appear that California's building standards should be reviewed to determine whether revisions are necessary to assure good indoor air quality. In fact, AB 191, Bradley (1987), and AB 4655, Tanner (1988), require the CEC to review its existing building standards for residential and non-residential buildings to determine whether modifications are needed to reduce the potential for indoor air pollution. The Tanner bill also requires the CEC to consult with DHS and ARB in the course of conducting the review, and additionally requires the CEC to consider potential IAQ impacts in developing new building standards.

Because the CEC review is to identify specific actions (changes to the standards) which should be taken, this report will make only limited recommendations related to building design and construction standards. One such recommendation is that current building standards should be amended to specifically require measures in new buildings which will minimize the entry of radon, at least in regions of known high radon risk as such regions become known. Current data indicate that such measures may only be necessary in limited areas of California. However, in those areas, such measures would be very important. Because radon is widespread, percolates through soil, and is drawn into buildings due to pressure differences, control efforts must focus on prevention of entry.

The Bonneville Power Administration's model conservation standards, which include radon monitoring and mitigation requirements for new residential buildings (see Appendix E), provide one example of how indoor radon problems may be addressed through building standards. In addition, the EPA has developed a technical guide regarding techniques for preventing/ reducing radon entry in new construction (EPA, 1987a), and is

currently developing model building codes (see Appendix B) for states to follow. Some of the techniques and model codes developed by EPA are applicable to California housing types and could provide initial guidance for California-specific standards. However, additional research is needed to determine the most cost-effective measures for California housing styles (see later section on research needs). Any new construction standards adopted in California in the near-term should be reviewed every three years to determine the need to amend them based on results of further California-specific research.

Recommendation 6: The many State and local agencies other than CEC that promulgate or adopt building standards should also conduct a review of their existing standards comparable to CEC's mandated review, to assure that indoor air quality is protected and not compromised by those standards.

Recommendation 7: As areas of high radon risk are identified, measures which minimize the entry of radon into new buildings should be incorporated into State and local building standards.

2. Need for Further Regulation of the Operation and Maintenance of Buildings and Ventilation Systems

Although a number of governmental bodies regulate the design and construction of buildings and ventilation systems, the operation and maintenance of buildings and ventilation systems remain inadequately regulated. Only the Minimum Building Ventilation Standard approved by the Occupational Safety and Health Standards Board in 1986 directly requires proper maintenance and operation of ventilation systems (see Appendix N). The Minimum Building Ventilation Standard requires that, in workplaces:

1. Heating, ventilation, and air-conditioning (HVAC) systems must be maintained and operated to provide at least the quantity of outdoor air required by the State Building Standards Code in effect at the time the building permit was issued;
2. HVAC systems must be operated continuously during work hours, except during emergency repairs and other specified periods; and
3. HVAC systems must be inspected annually, and inspection and maintenance records must be kept by the employer.

Although simple and not necessarily the traditional type of "standard," the Minimum Building Ventilation Standard provides for important, minimal components of any indoor air quality management plan. By far the greatest single category of problems which results in unhealthy indoor air quality is inadequate operation and maintenance of ventilation systems. Nearly 500 NIOSH investigations of office buildings over many years revealed inadequate ventilation to be the causative factor in 52 percent of the cases (Crandall, 1988). Analysis of complaints received in 1984 and 1985 by the San Francisco and Berkeley District Offices of Cal-OSHA revealed that 22 percent of the non-industrial IAQ problems in those areas involved inadequate ventilation. Cal-OSHA staff believed this to significantly underestimate the actual proportion of ventilation problem cases, due to underreporting and mis-classification of complaint cases (Cal-OSHA, 1986).

Because the Minimum Building Ventilation Standard applies to workplaces, however, its enforcement is largely dependent on worker complaints and inspections by Cal-OSHA enforcement staff. Members of the public who use public or commercial buildings which are not their place of employment have little recourse if they find a building too stuffy or are made ill by poor air quality. In buildings where the number of public users greatly exceeds the number of workers or where the public is in an area not frequented by employees of the building (such as a theater or auditorium), poor air quality conditions due to inadequate ventilation could realistically continue for some time without a worker complaint or appropriate inspection. The air quality is then dependent on the knowledge and conscientiousness of the building manager or owner, which should not necessarily be relied upon in buildings frequented by members of the general public.

A general standard at least equivalent to the Minimum Building Ventilation Standard is needed for all non-residential buildings (i.e., public and commercial buildings) and for group residential buildings where occupants do not control the ventilation system, in order to protect not only workers but members of the public using various types of buildings. Such a measure could prevent significant numbers of sick building problems

each year. The new standard, however, should also include active inspection and enforcement provisions to be carried out at the local level. The operation of ventilation systems in new buildings should be thoroughly checked by local building inspectors prior to occupancy of buildings, and members of the public should be able to turn to local officials for enforcement of the standard's provisions when necessary. To implement and enforce the standard, local governments should be provided the additional resources needed.

Recommendation 8: The operation and maintenance of all non-residential and group residential buildings and ventilation systems should be regulated at least to the extent provided for by Cal-OSHA's Minimum Building Ventilation Standard, that is, that heating, ventilation, and air conditioning systems should be operated and maintained as they were intended to be. In addition, any new standard developed for operation and maintenance should include provisions and resources for active inspection and enforcement by appropriate local officials.

D. EDUCATION NEEDS AND RECOMMENDATIONS

There is a need for increased education efforts regarding indoor air quality. As discussed earlier in this report, individuals can significantly affect their own personal exposures to indoor air pollutants through actions they do or do not take, and public agencies can knowingly or unknowingly affect indoor air quality in carrying out their respective mandates. Knowledge and actions of local government personnel are particularly critical in reducing citizens' exposures to pollutants, since they are the ones to whom citizens first turn for information and assistance.

Federal, state, and some local agencies and a number of private groups such as the American Lung Association have initiated public education efforts regarding indoor air quality. A number of fact sheets, brochures, and guidebooks have recently become available on various aspects of indoor pollution. However, public demand for information and assistance is increasing, and citizens near the lower end of the socioeconomic ladder are often not reached by initial public education efforts. To assure that all citizens have adequate and accurate information available to assist them in protecting their health, a

concerted effort to provide information to all Californians should be made. That effort should include development of additional fact sheets and brochures as needed; distribution of information to all households through mailings with vehicle registration renewal notices (with smog certification information, etc.), with monthly utility bills, or other similar means; and increased government agency participation in home improvement fairs and presentations to schools and other appropriate groups.

Similarly, additional efforts should be made to provide training and informational resources to State and local agency personnel. At the State level, some agencies are not yet fully aware of how their actions--regulatory and others--may affect indoor air quality. Additional information would better enable them to protect indoor air quality in the course of carrying out their respective missions. At the local level, personnel such as building inspectors, county health and environmental health department staff, and air pollution control district staff are generally required to deal with many types of problems and have many demands on their time and resources. To adequately respond to citizens' requests for information and assistance, they need appropriate materials for distribution as well as specific training related to addressing indoor air quality problems. The Department of Health Services has developed a protocol for local health officers and others to follow in conducting inspections of problem buildings and intends to offer training seminars for them in the near term. More such training seminars are needed and should be broadened to include other agency personnel as well, such as local building inspectors and air pollution control district staff. Similar training seminars for various State agency personnel appear necessary as well.

Recommendation 9: Public education efforts should be increased through development and statewide distribution of additional informational materials. Targeted indoor air quality training seminars should be developed and provided by knowledgeable State agency staff for other State agencies and for local agency personnel such as building inspectors, county health and environmental health department officers and staff, and air pollution control district staff.

E. CONTINUING RESEARCH NEEDS AND RECOMMENDATIONS

Despite an increase in IAQ research in recent years, there are still many critical gaps in our knowledge regarding all aspects of IAQ. EPA indoor air quality resource allocations are low relative to the apparent risk posed by indoor pollutants versus other environmental health risk categories, according to an EPA comparison of environmental risks and EPA resources allocated to addressing them (EPA, 1987b). At the State level, testimony at a hearing to review toxics and environmental budget priorities before the Assembly Ways and Means Committee in March, 1988, indicated that California's expenditures on IAQ relative to the risk it poses (using EPA's relative risk assignments) are also low (Legislative Analyst, 1988).

At the federal level, EPA, DOE, and DHHS have conducted significant research focused on development of indoor monitoring methods and equipment, ventilation factors, the effect of energy conservation measures on IAQ, and the health effects and biological fate of indoor (and outdoor) air pollutants. Within California, the DHS Indoor Air Quality Program has conducted major studies of formaldehyde, asbestos, and radon (as mandated by the Legislature and/or with specially allocated funds) and a number of other studies covering a wide variety of IAQ topics, including sick building studies, recent efforts to determine the efficacy of new building "bake-outs", and methods development studies for measuring volatile organic chemicals and ventilation rates. The ARB has funded: studies of Californians' activity patterns to determine where and how Californians' spend their time with regard to proximity and potential exposure to pollutant sources; VOC and PM₁₀ indoor monitoring methods development studies jointly funded with EPA; a study to develop indoor monitoring methods for PAHs; and a statewide radon monitoring survey (conducted by DHS). The ARB has also developed an Indoor Air Quality/Personal Exposure Five-year Study Plan.

Despite these significant initial efforts, many important information gaps related to assessing and mitigating indoor air pollution

in California remain. Some of these include:

- o California indoor concentrations and personal exposure levels of many pollutants;
- o actual risk posed by indoor or personal exposures to many pollutants in California;
- o health and economic consequences of California indoor pollution;
- o causes of sick building/new building syndrome and their relative significance;
- o effectiveness of new building "bake-outs" to reduce concentrations of volatile organic compounds;
- o emission rates and risks of volatile organic compounds emitted from many consumer products, building materials and furnishings, and other indoor sources; and
- o potential synergistic (greater than additive) effects among mixtures of indoor pollutants.

Recommendation 10: State agencies should gather the additional information needed to accurately and adequately determine the health risks posed by exposure to indoor pollution in California, the economic consequences of indoor exposures, and effective mitigation measures to reduce or prevent those exposures.

V. STAFF RECOMMENDATIONS TO THE BOARD

Staff recommends that the Board:

- A. Accept and endorse the findings and recommendations of this report.
- B. Direct staff to develop, in conjunction with other State agencies, a State plan for action to assure reduction, and where feasible prevention, of exposure to indoor air pollutants. The plan should rely on existing authorities to the extent feasible and include memoranda of understanding among appropriate State agencies. The plan should include explicit goals, objectives, target dates, and progress review periods.
- C. Direct staff to develop, for Board consideration, health-based indoor air quality guidelines for non-occupational indoor environments, in order to identify safe indoor exposure levels for Californians when such levels can be identified, and to provide guidance in reducing indoor exposures to pollutants for which safe levels of exposure cannot be identified.

- D. Direct staff to assist the Department of Health Services and other appropriate State and local agencies in developing indoor air quality education programs.
- E. Direct staff to continue indoor air quality research at a priority level consistent with the apparent risk of indoor exposures and available resources.
- F. Encourage the U.S. Congress and relevant federal agencies to take additional actions to control, and to coordinate the control of, sources of indoor pollution.

REFERENCES

- ACGIH, 1985. Threshold Limit Values for Chemical Substances in the Work Environment Adopted by ACGIH with Intended Changes for 1985-86; American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1985.
- Adler, RS, Pittle, RD, 1984, Cajolery or command: Are education campaigns an adequate substitute for regulation? Yale Journal on Regulation 1: 159.
- Allen, JP, Turner, EJ, 1988. Where to find the new immigrants. American Demographics September: 23.
- Anderson, 1988. "Chlorinated Pesticides in Indoor Air" by David Anderson and R. Hites, Environmental Science Technology, Vol. 22, No. 6, June, 1988.
- ANR, 1987. California City and County Smoking Ordinances, Americans for Nonsmokers' Rights, Berkeley, California, June 14, 1987.
- ANR, 1988. Matrix of Local Smoking Ordinances, Americans for Nonsmokers' Rights, Berkeley, CA, August, 1988.
- ARB, 1987. Indoor Air Quality and Personal Exposure Briefing Paper, Research Division, California Air Resources Board, Sacramento, May 1987.
- ARB, 1988. Indoor Air Quality/Personal Exposure Five-Year Study Plan, Research Division, California Air Resources Board, Sacramento, February 1988.
- Asch, P, 1988. Consumer Safety Regulation: Putting a Price on Life and Limb. Oxford University Press, New York.
- Barnes, 1987. A. James Barnes, EPA Deputy Administrator, to Honorable George Mitchell, U.S. Senator, letter dated June 1, 1987.
- BCEL, 1986. What if you couldn't read. Business Council for Effective Literacy: A Newsletter for the Business Community 1(8): 3, July.
- BCEL, 1987. Literacy in a new language. BCEL Newsletter 1(10): 1, January.
- BCEL, 1988. Service provision: recent gains, current problems. BCEL Newsletter No. 14: 1, January.
- BCEL, 1989. Literacy: a key to legal status. BCEL Newsletter 15: 3, April.
- BLS, 1988. Occupational Injuries and Illnesses in the United States by Industry, 1986, U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2308, May 1988.
- Cal-OSHA, 1985. A Guide to Cal-OSHA, California Department of Industrial Relations, San Francisco, June, 1985.

Cal-OSHA, 1986. Final Statement of Reasons, Draft, Title 8, Ch. 4, Subch. 7, Article 107, Section 5142 of the General Industry Safety Orders, Minimum Building Ventilation; Occupational Safety and Health Standards Board, November 20, 1986.

Canada, 1987. Exposure Guidelines for Residential Indoor Air Quality: A Report of the Federal-Provincial Advisory Committee on Environmental and Occupational Health; Department of National Health and Welfare, Ottawa, Canada, April 1987.

CDFA, undated. Report of Pesticides Sold in California for 1981, Division of Pest Management, CDFA, Sacramento.

CDFA, 1985. Employee Exposure to Pesticide Residue and Nuisance Dust During the Mechanical Shaking and Sweeping of Almond Harvest During August and September 1984, Worker Safety and Health Branch, CDFA, Sacramento, January 11, 1985.

CDFA, 1988. California Summary of Illness and Injury Reported by Physicians as Potentially Related to Pesticides, Worker Health and Safety Branch, CDFA, Sacramento, September 27, 1988.

Crandall, 1988. NIOSH Indoor Air Quality Investigations: 1971 through 1987; MS Crandall, paper presented at the 81st Annual Meeting of the Air Pollution Control Association, Dallas, Texas, June 1988.

DCA, 1982. Clean Your Room! A Compendium on Indoor Pollution, Department of Consumer Affairs, Sacramento, CA, February, 1982.

Decker, 1988. Personal communication, Ray Decker, Chief of Registration and Product Experience, U.S. Food and Drug Administration, April 2, 1988.

Deukmejian, G, 1988. Governor's Budget, 1988-1989.

DIR, 1986. California Department of Industrial Relations 1984-85 Biennial Report, Ron Rinaldi, Director.

DIR, 1988. California Department of Industrial Relations 1986-1987 Biennial Report, Ron Rinaldi, Director.

Dixon, DA, Vargo, M, Campbell, DW, 1987. Illiteracy in California: Needs, Services & Prospects. SRA Associates, Cotati, CA. Prepared for California State Department of Education, Sacramento, CA, July. Vocational and Occupational Information Center for Educators, Sacramento, CA.

DOF, 1988. Estimates of Refugees in California Counties and the State: 1987. Population Research Unit, Department of Finance, Sacramento, CA. Report SR 87-1.

Eberle, 1988. Personal communication, Sandy Eberle, Program Manager, Chemical Hazard Program, Consumer Product Safety Commission, Washington, D.C., June 10.

Edmiston, S, 1987. Human Illnesses/Injuries Reported by Physicians in California Involving Indoor Exposure to Pesticides Containing Chlorpyrifos, DDVP and/or Propoxur, 1983 - 1986. HS-1431, August 27. California Department of Food and Agriculture, Worker Health and Safety Branch, Sacramento, CA.

EPA, 1979. Summary of Reported Pesticide Incidents Involving Propoxur, Report No. 266, Pesticide Incident Monitoring System, Office of Pesticide Programs, U.S. EPA, November.

EPA, 1980. Summary of Reported Pesticide Incidents Involving Chlordane, Report No. 360, Pesticide Incident Monitoring System, Office of Pesticide Programs, U.S. EPA, July.

EPA, 1981. Summary of Reported Pesticide Incidents Involving Dichlorvos, Report No. 403, Pesticide Incident Monitoring System, Office of Pesticide Programs, U.S. EPA, January.

EPA, 1987a. Radon Reduction in New Construction, An Interim Guide; Offices of Air and Radiation and Research and Development, U.S. Environmental Protection Agency, OPA-87-009, Washington, D.C., August 1987.

EPA, 1987b. Unfinished Business: A Comparative Assessment of Environmental Problems, Office of Policy Analysis, U.S. Environmental Protection Agency, Washington D.C., February, 1987.

FDA, 1986. Cosmetic Handbook, FDA Center for Food Safety and Applied Nutrition, October 1986.

Ferriera, 1989. Personal communication with Mary Lynn Ferriera, Registrar of the California Structural Pest Control Board, January 11, 1989.

Fise, 1988. Personal communication, M.E. Fise, Consumer Federation of America, Washington, D.C., December 13, 1988.

FTC, 1981. Staff Report on the Cigarette Advertising Investigation. Federal Trade Commission, as cited in USSG, 1989, p. 481.

GAO, 1988a. Indoor Radon: Limited Federal Response to Reduce Contamination in Housing. Report to the Honorable Frank R. Lautenberg, U.S. Senate, from U.S. General Accounting Office, GAO/RCEB-88-103, April.

GAO, 1988b. Testimony: OSHA's Resumption of Private Sector Enforcement Activities in California, U.S. General Accounting Office, GAO/T-HRD-88-19, June, 1988.

Hayward, 1989. Personal communication, Steven Hayward, Manager, IAQP, DHS, February 16, 1989.

HCD, 1988. California Statewide Housing Plan, Phase II, Publication #102, California Department of Housing and Community Development, Sacramento.

Hill, 1988. Letter from E. Hill, Legislative Analyst, to Assembly member Sally Tanner, February 19, 1988.

IAQU, 1988. "Chlorpyrifos - Pest Control with Caution", Indoor Air Quality Update, Vol. 1, No. 1, September, 1988.

INS, 1987. Detail Run 414, Immigrants Admitted by Specified Countries of Birth and State and Zip Code of Intended Residence, Fiscal Year 1987, p. 2. Immigration and Naturalization Service, U.S. Department of Justice, Washington, DC.

INS, 1988. Detail Run 414, Immigrants Admitted by Specified Countries of Birth and State and Zip Code of Intended Residence, Fiscal Year 1988, p. 2.

INS, 1989. Provisional Legalization Application Statistics. Statistical Analysis Branch, Office of Plans and Analysis. January 27.

IPN, 1988. "Federal Judge Fines Orkin \$500,000, Blames Death of Virginia Couple on Firm," Indoor Pollution News, Vol. 1, No. 22, December 1, 1988.

Jablonsky, 1988. Memorandum to James D. Boyd, ARB, "Information Regarding Authority and Activities Related to Indoor Air Quality", from Steven A. Jablonsky, Executive Officer, California Occupational Safety and Health Standards Board, January 6, 1988.

Jablonsky, 1989. Personal communication, Steven A. Jablonsky, Executive Officer, California Occupational Safety and Health Standards Board, February 3, 1989.

Jennings, 1986. "Analysis of ARB and District Authority Regarding Indoor Air Quality." Memorandum from Thomas Jennings, Staff Counsel, ARB, to David Nawi, General Counsel, ARB, November 14, 1986.

Jones, 1989. Personal Communication, Tobi Jones, Chief of Pesticide Registration and Agricultural Productivity, California Dept. of Food and Agriculture, January 13.

Kasin et al., 1975. Study of Outside Air Usage. Kasin, Guttman & Associates, Consulting Engineers, Mechanical; San Francisco, CA. Prepared for Department of Housing and Community Development, Contract No. 371.

Kizer, 1988. Memorandum from Dr. Kenneth W. Kizer, Director, DHS, to James D. Boyd, Executive Officer, ARB, March 22, 1988.

Krieger et al., 1989. Illnesses/Injuries Related to Occupational Exposure to Propetamphos in California, 1982 through 1987, by RI Krieger, S Edmiston, and DM Richmond, California Department of Food and Agriculture, January 20, 1989.

Lacy, 1988. For Safety's Sake: State regulation of environmental hazards risks pre-emption. Los Angeles Daily Journal, December 5.

Lacy, 1988. "State Regulation of Environmental Hazards Risks Pre-emption," by James V. Lacy, Los Angeles Daily Journal, December 5, 1988.

Legislative Analyst, 1988. Rankings of Environmental Problems in EPA Report "Unfinished Business", California Expenditure Data Provided by the Legislative Analyst, March 1988.

Liddle, 1988. "Chlordane: The Last Cyclodiene," by John A. Liddle, Health and Environment Digest, Vol. 2, No. 11, December 1988, p. 3.

Lingau, F, 1988. Division of Codes and Standards, HCD. Personal communication, November 22.

Macher, 1988. Personal Communication, Janet Macher, Indoor Air Quality Program, Dept. of Health Services, October, 1988.

Mackay et al, 1988. The Southern California Air Quality Study: Tunable Diod Laser Absorption Spectrometer Measurements of H₂O₂ and H₂CO at the Claremont and Long Beach "A" Sites, by GI Mackay, DR Karecki,² and HI Schiff, Unisearch Associates, Inc., Nov. 9, 1988. Final Report, ARB Contract A732-073.

McClellan, 1989. Personal Communication, Ken McClellan, Office of the State Architect, DGS, January 9, 1989.

McGowan, J, 1988. Manufactured Housing Section, HCD. Personal communication, September 30.

McNamee, C, 1988. Division of Codes and Standards Section, HCD. Personal communication, October 21.

NIOSH, 1987. Criteria for a Recommended Standard...Occupational Exposure to Radon Progeny in Underground Mines, DHHS/NIOSH, October, 1987.

NIOSH, 1988. NIOSH Recommendations for Occupational Safety and Health Standards, 1988, Morbidity and Mortality Weekly Report, August 26, 1988, Vol. 37, No. 5-7.

NOMOS, 1979. California Adult Competency Survey. Prepared for California Department of Education. NOMOS Institute, Berkeley, CA and Honolulu, HA. March, 1979.

NRC, 1981. Indoor Pollutants, National Research Council, National Academy Press, Washington, D.C.

NRC, 1987. Counting Injuries and Illnesses in the Workplace: Proposals for a Better System; National Research Council, National Academy Press, Washington, D.C., September 1987.

NRC, 1988. Health Risks of Radon and Other Internally Deposited Alpha-Emitters, BEIR IV; Committee on the Biological Effects of Ionizing Radiations, National Research Council, National Academy Press, Washington, D.C., 1988.

OSHA, 1987. Report of the President to the Congress on Occupational Safety and Health for Calendar Year 1986; U.S. Department of Labor, Occupational Safety and Health Administration, Washington, D.C., August 3, 1987.

OHSEP, 1987. Indoor Air Quality Manual--Summary of Needs Assessment Survey. Occupational Health Surveillance and Evaluation Program, Department of Health Services, Berkeley, June.

O'Malley, M, 1989. A review of first-aid information on pesticide labels. Journal of Veterinary and Human Toxicology. June.

Pitts, TE, 1988. Deputy Director, HCD. Personal communication, November 30.

Quinton, 1986. Memorandum to Peggy Jenkins, ARB, from J. David Quinton, Local Environmental Health Services Branch, DHS, September 19, 1986.

Reed, 1988. Letter to J.D. Boyd, Executive Officer, ARB re: IAQ authority and activities, from C.D. Reed, Director, HCD, January 21.

Repace and Lowrey, 1985. A Quantitative Estimate of Nonsmoker's Lung Cancer Risk from Passive Smoking, JL Repace and AH Lowrey, Environment International 11:3-22.

Roberts and Warren, 1987. "Sources of Toxics in House Dust," John W. Roberts and Guylyn R. Warren, Int. J. Biosocial Research, Vol. 9(1): 82-91

Robinson, 1977. How Americans Use Time: A Social-Psychological Analysis of Everyday Behavior, JP Robinson, Praeger, New York.

SAI, 1984. Formaldehyde: A survey of airborne concentrations and sources, Science Applications, Inc., ARB Research Report, Contract no. A2-059-32.

Schaefer, 1987. Cal-OSHA AND FEDERAL OSHA: Significant Differences, A Senate Industrial Relations Committee Oversight Report, by Andrew Schaefer, Senate Office of Research, Sacramento, December 1987.

Sexton et al., 1986. Characterization of Indoor Air Quality in Wood-burning Residences; K Sexton, KS Liu, RD Treitman, JD Spengler, WA Turner, Environment International, v. 12, pp. 265-278, 1986.

Solorzano, R, 1989. Educational Testing Service, Los Angeles, CA. Personal communication, April 6.

SOR, 1986. Invisible Citizenship: Adult Illiteracy in California. K. Connor, Senate Office of Research, Sacramento, CA. March.

SOR, 1988. Pesticides at Home: Uncertain Risks and Inadequate Regulations, California Senate Office of Research, April 1988.

Staelin, R, 1978. The effects of consumer education on consumer product safety behavior. Journal of Consumer Research 5:30.

Standards Board, 1988. Occupational Safety and Health Standards Board Role and Responsibilities, dated December, 1988.

Surgeon General, 1986. The Health Consequences of Involuntary Smoking: A Report of the Surgeon General; Office on Smoking and Health, U.S. Department of Health and Human Services, Rockville, Maryland, 1986.

Surgeon General, 1988. The Health Consequences of Smoking: Nicotine Addiction, A Report of the Surgeon General; Office on Smoking and Health, U.S. Dept. of Health and Human Services, Rockville, Maryland.

Szalai, A (ed.), 1972. The Use of Time: daily activities of urban and suburban populations in twelve counties. Mouton, The Hague.

USSG, 1989. Reducing the Health Consequences of Smoking: 25 Years of Progress. U.S. Surgeon General, Office on Smoking and Health, U.S. Department of Health and Human Services, Rockville, MD.

WESTAT, 1987. Household Solvent Products: A National Usage Survey. Rockville, MD. Prepared for U.S. Environmental Protection Agency, Washington, DC. EPA-OTS 560/5-87-005, July.

Wells, 1988. An Estimate of Adult Mortality in the United States From Passive Smoking, A. Judson Wells, Envt. Intl., Vol. 14:249-265.

